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The Appropriateness Of Heart Rate And Rating Of Perceived Exertion As A Measure Of Intensity During Three Variations Of Aerobic Dance

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THE APPROPRIATENESS OF HEART RATE AND RATING OF PERCEIVED EXERTION AS A MEASURE OF INTENSITY DURING THREE VARIATIONS OF AEROBIC DANCE

ROACH

The Appropriateness of Heart Rate and Rating of Perceived Exertion as a Measure of Intensity during Three Variations of Aerobic Dance

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ABSTRACT

The Appropriateness of Heart Rate and Rating of Perceived Exertion as a Measure of Intensity during Three Variations of Aerobic Dance

Brendan Roach

Previous research has shown that the heart rate (HR) response can be disproportionate to increases in oxygen uptake (VO_2) during aerobic dance. The purpose of this study was to examine the VO_2-HR and VO_2-rating of perceived exertion (RPE) relationship during three variations of aerobic dance and treadmill (TM) exercise. Thirteen healthy subjects (1 male, 12 female) were examined during 39 minutes in each of Step Aerobics (STEP), Interval Aerobics (INT), and High/Low Impact Aerobics (HI/LO). Sixteen minutes of TM exercise was also examined. Variables measured included VO_2, HR, and RPE. Correlations, regression equations and analysis of variance were used to analyze the data. Data for VO_2 and HR was presented as a percentage of maximum. Absolute values were used for RPE. Results showed that the regression lines were significantly different ($p<0.01$) for the VO_2-HR relationship. The regression lines for aerobic dance were always above the line for TM exercise. Therefore, at a given VO_2, the HR response during aerobic dance was always higher. The regression lines were not significantly different ($p<0.01$) for the VO_2-RPE during the three variations of aerobic dance and TM exercise. Further analysis of the data revealed that the 60-90% HR_{max} training zone was achieved by the STEP, HI/LO and INT treatments for 35, 32 and 34 minutes respectively. Thus when monitoring by HR, intensity (VO_2) would seem adequate. However, when time within the 50-85% VO_{2max} training zone was analyzed, the STEP treatment maintained this for 31 minutes, whereas the

HI/LO and INT treatments maintained this zone for 15 and 7 minutes respectively. Results indicate that for aerobic dance, it is may not be appropriate to use HR as a method to monitor intensity under the current guidelines provided by the ACSM. It appears that RPE is more appropriate. However, it is hypothesized that the music during the aerobic dance videotapes could have depressed subjects RPE slightly. Large individual differences were also noted at the same intensity. Therefore, results indicate that if heart rates are used, training should be 10 percent higher than those currently recommended ie. instead of 60-90% HR_{max} it should be 70-100% HR_{max}. This should be used in conjuction with the RPE scale but the zone could be lowered slightly to account for the effects of music.

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Chapter I

INTRODUCTION

Aerobic dance began as part of the 'cult of fitness' of the early 1970's when Jacki Sorenson first pioneered aerobic dance classes for the public. From small beginnings, the boom has reached extraordinary dimensions all over the world. In the United States alone, 23.3 million people participate in aerobic dance (National Sporting Goods Association, cited in Bernstein, 1991).

A significant force behind the fitness movement was Dr. Kenneth Cooper, an Air Force Physician. He established a simple method to help people achieve the correct quality and quantity of exercise necessary to guarantee fitness. The ideas Dr. Cooper presented in his book "Aerobics" in 1968 was the answer for an estimated 8 million Americans.

Followers of the fitness cult continued to multiply in numbers. Throughout the 1970's and 1980's more than 20 million Americans regularly ran, swam, cycled, weight lifted, played racquetball or participated in aerobic dance (Roberts & Olsen, 1989). This had significant impact on the fitness industry. Health clubs in the United States increased from 350 in 1968 to more than 7000 in 1986 (Roberts & Olsen, 1989).

Roberts and Olsen (1989) reported that,

> "By the end of the 1980's sports had become the secular religion of America. The stadiums, tanning salons, health

> spas, and gymnasiums had become the new cathedrals; jogging, running, aerobic dancing, cycling, weight lifting, and dieting the new rituals; and televised events, newspapers, radio talk shows, and sports and health magazines the new liturgies. The most obsessive athletes have a disciplined devotion that even the most ascetic medieval saints would have envied." (p.234).

People are attracted to aerobic dance primarily for weight control and general fitness. They keep coming back primarily for the fun element (Roach, 1991). A variety of classes are now offered in an attempt to cater to participants needs. High impact, low impact, step, cardio funk, triaerobics and interval aerobics are among the selections available. Conflicting evidence exists as to the effectiveness of such classes.

Training studies in aerobic dance conducted over 7-12 week periods, 3 days per week for 30-45 minutes, have found significant improvements of 10.2-11% in maximal oxygen uptake (VO_{2max}), (Clearly, Moffat, Knuttzen, 1985; Parker, Hurley, Hanlong, Vaccaro, 1989; Milburn & Butts, 1983). This improvement is less than that found in studies using more conventional modes of aerobic activity. Cycle ergometer training studies (Atomi, Iwasaki, Miyashita, 1978) and bench stepping/treadmill studies (Eisenman & Golding, 1975) have found a 16-17.6% improvement in VO_{2max}. Both of these latter studies used subjects with similar initial VO_{2max} levels as the aerobic dance studies. Training intensity, frequency and duration were also similar. Other studies that have used different training methodologies and initial VO_{2max} levels have shown

improvements of 16-44% for cycle ergometer, treadmill and bench step training (Hickson, Bromze, Holloszy, 1977; Fringer & Stull, 1974; Edwards, 1974). Milburn and Butts (1983) found a 8.2% improvement in VO_{2max} following a jogging program conducted four days per week for 30 mins each over a seven week period.

Russell (1983) found no improvement in cardiovascular function following an aerobic dance program. Nelson, Pels, Geenen & White (1988) found aerobic dance to only minimally meet guidelines set by the American College of Sports Medicine (ACSM). However, interval aerobic dance has been shown to improve VO_{2max} by 18% over a 12 week period (Perry, Mosher, La Perriere, Roalstad & Ostrovsky, 1988). More recently Olson, Williford, Blessing & Greathouse (1991) examined the effects of step aerobics at varying bench heights. Each condition put subjects within recommended percent VO_{2max} target zones as recommended by the ACSM (1990). The question arises as to why aerobic dance appears to be generally less effective than other modes of exercise.

It has been suggested that the smaller VO_{2max} improvements in aerobic dance have been found as a result of disproportionately higher heart rates without a corresponding increase in VO_2 (Cline, Berry, Berry, & Davis, 1990). This is thought to be the result of extensive use of the arms. Toner, Glickman & McArdle (1990) have found that when greater than 25 percent of the total power output is contributed by the arms, there is a consistent decrease in stroke volume (SV). A lower cardiac output (Q) and a higher heart rate (HR) are also observed.

In aerobic dance, intensity can be monitored by measuring HR. Participants assume they are exercising at adequate levels if they reach a particular target zone recommended by the ACSM (1990). If extensive use of the arms creates a dispropionate increase in HR due to a decreased SV, it may be assumed that a training effect is being achieved when, in actuality it may not be so.

Rating of perceived exertion (RPE) is another method that can be used to monitor intensity. This method allows participants to subjectively monitor their intensity by how hard they feel they are working. This has been shown to be a valid and reliable method during cycling and running (Borg & Linderholm, 1970; Stamford, 1976; Dunbar, Robertson, Baun, Blandin, Metz, Burdett & Goss, 1992). No such studies have been found regarding the validity and reliability of this method during aerobic dance.

The measurement tool that can best relate to VO_2 during aerobic dance, should be adopted by aerobic instructors. This study was designed to investigate three factors. Firstly, are current target heart rate values a valid estimate of intensity (VO_2) during aerobic dance. Secondly, do current target heart rate values need modification to be valid during aerobic dance. Thirdly, is RPE a better estimate of intensity (VO_2) during aerobic dance. The findings will have implications in the fitness industry regarding the monitoring of intensity.

Purpose

The purpose of this study was to determine the relationship between oxygen uptake (VO_2), heart rate and rating of perceived exertion during three variations of aerobic dance and during treadmill walking/running. Results of this study will have practical applications regarding the monitoring of intensity during aerobic dance.

Hypotheses

1. There is no difference in the VO_2-HR regression for three variations of aerobic dance and treadmill walking/running.

2. There is no difference in the VO_2-RPE regression for three variations of aerobic dance and treadmill walking/running.

Limitations

1. This study was limited to 13 subjects. It was difficult to find subjects who had a long term history of participation in aerobic dance. Some of the aerobic dance routines required a high degree of co-ordination. For some subjects this limited their ability to exercise at higher intensities.

2. Five of the original 18 subjects dropped out of the study. Of these, three dropped out because of illness, one dropped out because of injury and one dropped out because of personal reasons. In addition to this, the data of one subject was dropped from the study. Co-ordination was a major problem for this subject. As a result, the intensity levels produced were too low to assist with the investigation.

3. It was assumed that heart rate responses were not influenced by any other factors than the exercise itself. However, subjects were only given one trial with each of the three aerobic dance videotapes. Therefore, apprehension with trying to follow the videotape may be an extraneous variable to consider.

4. Music was not used during the treadmill protocols. It was incorporated into the aerobic dance videotape routines. This may have influenced subjects rating of perceived exertion.

Definition of Terms

Aerobic Dance. Choreographed cardiovascular exercise performed to music.

Heart Rate. "The number of ventricular beats per minute" (Astrand and Rodahl 1986, p.738)

Hi/Lo Aerobics. A combination of high impact and low impact aerobic dance routines. Movements include any combination of running, jumping, marching, skipping, and lunging. Arm movements are combined with leg movements.

Interval Aerobics. Aerobic dance routines based on interval training methods. Combinations of high and low impact routines are used during the work interval and recovery strength exercises with a rubber 'exertube' are used during the rest interval.

Interval Training. "Exercise in an intermittent manner using a pre-established spacing of work and rest interval" (McArdle, Katch, & Katch, 1991, p.140)

Oxygen Uptake (VO2). "The volume of oxygen (STPD) extracted from the inspired air, usually expressed in liters per minute VO_2." (Astrand & Rodahl, 1986, p.738).

Rating of Perceived Exertion (RPE). The RPE scale consists of numbers from 6 to 20. Descriptive phrases of exertion levels appear alongside each odd number. A "very, very, light" exertion level corresponds to a 7 and ranges up to a "very, very, hard" exertion level which corresponds to a 19. The values used were chosen to relate closely to one-tenth of the heart rate (Borg, 1962).

Step Aerobics. Aerobic dance routines performed with the aid of a step bench.

Chapter II

REVIEW OF LITERATURE

Oxygen Uptake-Heart Rate Relationship during Aerobic Dance

The American College of Sports Medicine (ACSM) recommendations regarding the quality and quantity of exercise to improve cardio-respiratory fitness include: (1) exercise at 50-85% VO_{2max} or 50-85% Heart Rate Reserve (HRR) or 60-90% maximal heart rate (HR_{max}) or 12-16 RPE (2) 20-60 minutes of continuous aerobic activty and (3) a mode of actvity that is continuous, rhythmical, aerobic which uses large muscle groups (ACSM, 1990). Typically in an aerobics class, intensity is monitored by palpating pulse rates. The zone of 60-90% HR_{max} has traditionally been used as a guideline for effective exercise intensity in a class. This is based on the linearity of the heart rate-oxygen uptake (exercise intensity) relationship (McArdle, Katch & Katch, 1991; Astrand & Rodahl, 1986). This relationship is based on studies using treadmills and cycling ergometers (Franklin, Hodgson, Buskirk, 1980; Taylor, Haskell, Fox, Blackburn, 1969, cited in Parker et al., 1989; Londeree & Ames 1976). Monitoring heart rates is a convenient way to estimate that an appropriate oxygen uptake is being achieved. Whether the same

relationship found with treadmills and cycling can be applied to aerobic dance is not completely understood.

Conflicting results appear in the studies which examine the VO_2-HR relationship during aerobic dance. Parker et al (1989) examined 14 untrained females during an eight week aerobic dance program conducted three days per week for 40 minutes. Subjects trained at 84% of HRmax. In addition to the training program, they compared heart rates during aerobic dance and treadmill running at the same percentage of VO_{2max}. A 10% higher heart rate was found during aerobic dance. At the end of the training program an 11% improvement in VO_{2max} was found. As this was lower than other training studies, it was concluded that the smaller increases were due to the disproportionate VO_2-HR relationship. In a similar study, three popular aerobic exercise videos and uphill treadmill walking were examined, (Hornsby, Dixon, Anderson & East, 1991). Eleven female subjects exercised at similar heart rates. A significantly lower VO_2 was found in the low impact aerobics (The Best of Bodies in Motion: Vol.2) and aerobic weight training (The Firm Aerobic Workout With Weights). However, the VO_2-HR relationship during uphill treadmill walking and traditional aerobic dance (Kathy Smith's Ultimate Workout) was not significantly different. The difference seen may be due to a greater proportion of total energy being produced by the legs as compared to the upper body during the latter two modes of exercise.

Disproportionate heart rate increases were not found by Cline et al., (1990) who utilized three, twenty minute exercise trials. These included aerobic dance with arms used extensively, aerobic dance with no arms

and treadmill running. Results showed a similar relationship between mean heart rates and percentage of VO_{2max} during aerobic dance and running. In addition, Reeves & Darby (1991) examined this relationship during a graded exercise test for aerobic dance and treadmill running. The slopes of the lines were examined using regression analyses. No significant difference in the slopes was found. These results were explained by the fact that both modes of exercise use a large muscle mass and train similar muscle groups.

Other studies have noted VO_2-HR relationship as a consequence of their research. Willifords, Henry, Blessing, Daniel, Olson, Smith, (1989) examined 10 women during four intensity levels of aerobic dance. Individual analysis of the data found that some subjects were working at near maximum heart rate without any major discomfort. One subject for example, was working at 94% of HR_{max}, 60% of VO_{2max} and a perceived exertion of 14 or "somewhat hard" which is somewhat below the maximum level. Therefore if one was monitoring intensity by HR alone it would suggest a need to slow down which would be incorrect. Previous studies (Toner, Sawka, Levine & Pandolf, 1983) note that a disproportionate increase in HR occurs if more than 60% of total body VO_2 is contributed by the arms. Toner, Glickman & McArdle (1990) have found that this can occur when more than 25% of the power output is contributed by the arms. Aerobic dance combinations can vary to a large degree with the contribution of arm and leg work. This factor could account for large variations.

Oxygen Uptake-Heart Rate Relationship during Upper Body Exercise

Disproportionate increases in heart rate have also been noted during dynamic high resistance exercise (bench press, bent-over row, arm curl and parrallel squat), (Collins, Cureton, Hill, & Ray, 1991; Hampel & Wells, 1985) compared with dynamic low resistance exercise (running or cycling). This result was not seen while carrying 1 lb and 5 lb hand weights when walking and jogging (Zarandona, Nelson, Conlee, & Fisher, 1986). Other studies which have examined arm exercise alone have found a significantly higher heart rate for a given oxygen uptake when compared with leg exercise (Bevegard, Freyschuss, & Strandell, 1966; Vokac, Bel, Baut-Holter, & Rodahl, 1975; Stenberg, Astrand, Ekblom, Royce, & Saltin,1967). Vokac et al (1975, p.58) suggested that "the enhanced heart rate in arm work reflects the reported higher pheripheral resistance and higher arterial blood pressure." This has also been reported in other studies (Sawka, 1986). Higher heart rates have also been shown to reflect a lower stroke volume during upper body work (Stenberg., et al 1967, Hempel & Wells, 1985). The examples given are different to that of aerobic dance. However they illustrate the effects of extensive upper body exercise which can occur in aerobic dance.

Mechanisms Involved in the Oxygen Uptake-Heart Rate Relationship

The mechanism underlying increased peripheral resistance could account for the higher blood pressure and lower stroke volume and thus higher heart rate during arm exercise. Cardiac output, in arm crank exercise is the same as that in cycle exercise (Sawka, 1991). Two factors affecting peripheral resistance are vessel radius and blood viscosity. If arm work (as in aerobic dance) is used extensively and in greater proportions than leg work, then the same cardiac output is perfusing a smaller vascular cross sectional area. Peripheral resistance would increase as a result. In addition Davis et al 1974 (cited in Sawka , 1991, p.192) reports that "plasma catecholamine concentrations are inversely related to the skeletal muscle mass used during submax exercise at a given oxygen uptake. " Therefore an increased sympathetic (vasoconstrictor) tone could result if arms are used extensively. (Sawka, 1991, Bevegard, et al., 1966, Collins et al., 1991). Peripheral resistance may increase as a consequence which is reflected in a lower stroke volume. This results in a higher heart rate to maintain cardiac output.

Aerobic dance can sometimes involve isometric contraction of some muscle groups. For example, bending the elbows while the upper arms remain horizontal to the ground would cause the deltoid, trapezius and rhomboids to contract isometrically. This isometric contraction plus a greater recruitment of fast twitch fibers may account for an increased

sympathetic vasoconstrictor tone and total peripheral resistance (Sawka, 1991; Collins et al., 1991). Often in aerobic dance the shoulders may be elevated in an isometric position while the lower arm and legs are performing dynamic exercise. Jackson et al (1973, cited in Sawka, 1991, p.192) has shown that "an isometric exercise component upon a dynamic exercise task elevates blood pressure above levels elicited by the dynamic task alone." This is known as the pressor response and is thought to be mediated by a reflex from the contracting skeletal muscle (McCloskey et al 1972, Petrofsky et al, 1984, cited in Sawka, 1991). This has also been shown to increase sympathetic vasoconstrictor tone (Mitchell et al., 1977, Muller et al., 1953, cited in Sawka 1991, p.208).

Mechanical compression of vasculature during upper body exercise could also increase peripheral resistance. If intramuscular tension exceeds perfusion pressure then this increase in total pheripheral resistance is due to less vascular cross sectional area being perfused. (Sawka, 1991, p.193).

Several investigators have reported higher heart rates during arm-crank compared with cycle exercise (Astrand et al., 1965; Bevegard et al., 1966; Davies et al., 1974; Stanbergy 1967, cited in Sawka, p.193). Elevated heart rates reflect increased sympathetic stimulation. Therefore this should increase myocardial contractility but this does not occur, (Miles et al., 1984, cited in Sawka, p.193). This is due to differences in cardiac filling or preload. Also, a decreased preload is due to a decrease in the skeletal muscle pump. This results in a decrease in the end-diastolic volume (Clausen, 1976 cited in Sawka, p.194). Therefore the

increased sympathetic stimulation needed to achieve similar myocardial oxygen uptake, also increases afterload. This results in impeding stroke volume (Sawka, 1991, p.194)

Collins et al (1991) have suggested that an increased heart rate is due to increased stimulation of chemosensitive afferent fibers by decreased muscle cell pH. It may also reflect different fitness levels for upper body work (Bergh, Kanstrup, & Ekblom, 1976).

Previous studies in aerobic dance have not accounted for the amount of time arms were in elevated positions (ie. above the head). Astrand, Guharay, Wahren, (1968) found that heart rate, blood pressure and lactate concentrations during arm exercise were higher for nailing into the ceiling than nailing into the wall or bench. The different hemodynamic responses were accounted for by an increased sympathetic vasoconstriciton for exercise with elevated arms. This positioning effect could account for some of the discrepancies seen. However, Cummings and Gladden (1983) examined arm cycling at three different intensities. Arms were positioned above, at and below heart level. No significant difference in hemodynamic responses were found. It was suggested that the difference found in this study compared with that of Astrand et al (1968) was due to variations in the static component of exercise treatments, (Cummins & Gladden, 1983). This study may be more applicable to aerobic dance.

Rating of Perceived Exertion

It is unknown whether Rating of Perceived Exertion (RPE) (Appendix F) during aerobic dance has a better correlation to VO_2 than HR. RPE was introduced by Swedish physiologist Gannar A.V. Borg (1962), as a means of subjectively evaluating exercise intensity. His studies showed people were good at perceiving physical costs of various workloads (r=0.80 to 0.90).

Other investigations have shown RPE to be valid and reliable with correlations of 0.74-0.90 reported (Borg & Linderholm, 1967; Skinner et al., 1969, Skinner et al., 1973, Bar-or et al., 1972, cited in Stamford, 1976; Stamford, 1976).

Several investigators have looked at possible central and peripheral mechanisms upon which RPE is based. Cafarelli & Noble (1976) found that ventilation was not shown to be a primary cue for selections of RPE. However, more recently Hetzler, Seip, Boutcher, Pierce, Snead, & Weltman, (1991) found a strong relationship between RPE and blood lactate concentrations during cycle and treadmill exercise in untrained individuals. This indicates that people relate intensity levels to relative feelings of discomfort. It makes sense then that blood lactate levels relate well with RPE since lactate is theorized to cause muscular discomfort.

RPE has been found to be "linearly related to heart rate during bicycle ergometry (Morgan & Borg, 1976, cited in Dunbar et al 1992, p.94), arm ergometry (Borg, 1961, cited in Dunbar et al., 1992, p.94), walking and

running (Robertson 1982, cited in Dunbar et al., 1992, p.94). No such relationship has been reported for aerobic dance. Also at a given submaximal VO_2 or HR, RPE has been shown to be higher during cycling as compared to running (Ekblom & Goldberg, 1971 cited in Dunbar et al.,1992). More recently, Dunbar et al (1992) examined whether RPE could be used to regulate intensity of exercise during treadmill and bicycle ergometry exercise modes. Previous studies had based their findings on RPE responses relating to a particular exercise intensity. In this study subjects were able to adjust intensity levels to achieve a RPE previously estimated. The earlier trials consisted of RPE responses to a particular workload during GXT on a treadmill. Results revealed that RPE "provides a simple and physiological valid method of regulating exercise intensity" (Dunbar et al.,1992, p.97).

Three limitations regarding the use of RPE have been noted (Rejeski & Kenny 1988). Firstly, novice exercisers lack experience regarding RPE. "It has been shown that, in the absence of sufficient external stimulation people focus more on physical symptoms" (Pennebaker, 1982 cited in Rejeski & Kenney, 1988, p.57). This would tend to elevate RPE responses in relation to heart rate response. Secondly individuals with Type A Behavior Patterns tend to be highly competitive and will often suppress RPE's (Rejeski & Kenney, 1988). However, recent reports have conflicted with these findings (Dishman, Graham, Holly, & Tieman, 1991). Thirdly, the RPE scale does not reveal feelings about exertion. For example a competitive cyclist may feel good exercising at an RPE of 17. For others a 17 may be very stressful.

Although limitations exist, RPE remains a valid and reliable method for monitoring intensity. As such, it can be very useful for group and individual exercise sessions. It is relatively easy to use and only small amounts of time are taken out of the exercise session to monitor intensity.

Summary

The VO_2-HR relationship during aerobic dance remains the subject of speculation at this point in time. The VO_2-RPE relationship is even more uncertain. The conflicting evidence could be due to the variety of arm and leg contributions to total energy cost at varying intensities.

Chapter III

METHODOLOGY

Introduction

Heart rate and rating of perceived exertion can be used to monitor intensity during aerobic dance. This study was designed to determine the effectiveness of these methods during three variations of aerobic dance. A description of subjects, the experimental setting, equipment used, treatments, and treatment of data are included in this chapter.

Subjects

Thirteen subjects (1 male, 12 female) volunteered for the study. Prior to participation a health history (Appendix A) and exercise history (Appendix B) questionnaire were administered. Subjects were selected if they were free from medical contraindications and had a history of regular attendance in aerobic dance classes as participants or instructors. Physical characteristics of subjects are shown in Table 1. Of the 13 subjects, 10 were instructors and three were participants. Subjects had participated in aerobics for 1.5 - 11.35 years (mean = 7.04 ± 3.15 years).

Table 1: Physical characteristics of subjects.

	Mean	SD	Range
Age (yrs)	28.92	± 8.49	19-42
Height (cm)	162.42	± 5.40	155-170
Weight (kg)	60.08	± 6.99	49.77-74.1
HR rest (bpm)	62.15	± 7.70	53-74
HR max (bpm)	182.69	± 11.28	167-201
VO2 max (ml/kg/min)	44.36	± 5.13	34.00-55.87

Setting

Investigations took place at the Eastern Illinois University Human Performance Laboratory. The room temperature ranged from 21-25 degrees celsius with a humidity of 32-55%. As these two factors could not be altered, a large fan was used to help cool all subjects during exercise.

Experimental Design (Overview)

Each subject came to the Human Performance Laboratory on five occasions. At least 48 hours followed the preliminary VO_{2max} test and at least 24 hours recovery followed all other sessions. Subjects provided informed consent prior to the preliminary measurements of height, weight, resting heart rate, resting blood pressure followed by a maximal oxygen uptake test. Subsequent visits consisted of aerobic dance workouts. Oxygen uptake, HR and RPE were monitored throughout each session.

Prior to coming into the laboratory each subject was provided with information (Appendix C) informing them of procedures for the investigation. The first visit also included an oral orientation to decrease anxiety prior to the graded exercise test.

Test of Maximal Oxygen Uptake

Heart Rate, VO_2 and RPE were recorded at 60 second intervals during a maximal treadmill test. The treadmill protocol (Appendix H) was performed on the Quinton Q65 motorized treadmill. Changes in speed and grade were controlled by a Quinton 2000 computer. Oxygen uptake was determined by using standard open circuit spiromety procedures during each stage of the graded exercise test (Consolazio, Johnson, & Pecora, 1963, cited in Nelson 1988, p.2). Nose clips were used and gas was collected through the Hans Rudolph two way respiratory valve.

Inspired minute ventilation was calculated with the Rayfield Ram 9200 air flow meter. Expired gases were analyzed with the Applied Electrochemistry SA-3 oxygen Analyzer and Applied Electrochemistry CD-3A Carbon Dioxide Analyzer. Their data was automatically collected and analysed by the REP-2000 B Data Acquisition System Developed by Rayfield Equipment Ltd, for use with an Apple IIe microcomputer. The computer printer produced an updated hard copy of oxygen consumptions, and respiratory exchange ratios every 60 seconds during the treadmill test.

Heart rate was recorded every 60 seconds with the Polar Pacer heart rate monitor. All heart rate records were stored in its memory until each test was completed. Each subject was asked to indicate a rating of perceived exertion every 60 seconds. Numbers were read out by the investigator and the subject signalled "thumbs up" when the appropriate number was read. All information was recorded on the data sheet (Appendix G). Subjects were given time to familiarize themselves with all testing procedures.

Termination of the test occured when subjects could go no further. Indicators for VO_{2max} included RER exceeding 1.00 to 1.10, heart rate achieving near maximum predicted values and a leveling off of VO_2 just before the subject is forced to stop. Leveling off criterior was indicated when VO_2 differed less than 150 ml/min or 2.1 ml/kg/min with an increase in workload. Two of the three criteria were necessary for the attainment of VO_{2max} to be accepted.

Submaximal values recorded during the first four stages were used for later comparisons to aerobic dance values. The maximal oxygen uptake test was repeated on nine of the 13 subjects for test-retest reliability. A significant correlation was found ($r = 0.951$) with a paired t value of 0.933 and a two-tail probability of 0.378.

Aerobic Dance Testing Sessions

Each subject was evaluated while following three 30 min videotaped aerobic routines. A 24 hour period was required between each workout. The workouts included a session of High Impact/Low Impact (HI/LO) combination aerobics, Interval (INT) aerobics and Step (STEP) aerobics. This variation was selected to represent the variety of aerobic dance classes that is currently offered. The STEP and INT aerobic videotapes were selected from "Shape" magazine's 1991 annual fitness videotape review. "Shape" is a well known health and fitness magazine. The tapes selected were given high ratings. The HI/LO videotape was choreograhed and performed by the investigator specifically for the study. The investigator has 9 years experience teaching aerobics. Each videotape included a 5-10 minute warm up preceeding the 25-30 min workout, followed by a five minute cool down. Thirty-nine minutes of each videotape was included in the evaluation. Oxygen uptake, HR and RPE were monitored throughout the routine. Respiratory tubing and the mouth piece was supported by a head supporting unit that each subject

wore. This allowed for greater non-restrictive movement. All data collection procedures were the same as those used in the treadmill protocol.

Prior to each videotaped workout the subjects were oriented to the equipment and procedures. Subjects were instructed to perform all movements as best they could. They were informed that a few overhead arms movements and travelling movements may be restricted because of the equipment. But they were to simulate these movements as closely as possible.

Hi/Lo Aerobics (HI/LO Combos with Brendan Roach B.Ph.Ed, M.S)

Various combinations of high impact and low impact routines were implemented during this tape. Greater emphasis was placed on low impact than on high impact routines. Some routines combined a combination of four movement sequences while others were single exercises. Music tempo ranged from 140-150 bpm during the aerobic component of the tape.

Interval Aerobics (Just Pump I.T with Troy DeMond M.A)

Subjects followed a pre-aerobics section which preceeded 6 cycles of intervals . Work: rest ratio was 3:1. Three minutes of high intensity (140-156 bpm) aerobic work cycles were followed by one minute of low intensity (120 bpm)exercise for active recovery cycles. A variety of high

impact and low impact routines were utilized during the high intensity aerobic interval. During the recovery interval an 'exertube' rubber device was used for a variety of dynamic strength movements.

Step Aerobics (Power Stepping with Lynne Brick R.N.)

Various step routines were followed. A Step Reebok bench was used for this workout. All subjects stepped on a bench height of 20.5 cm. Music tempo remained constant at approximately 120 bpm.

Analysis of Data

A Pearson product moment correlation was performed on all dependant variables to determine the relationship between VO_2 and HR, and VO_2 and RPE during the three variations of aerobic dance and treadmill exercise.

Regression analysis was used to determind the equation for each relationship. Londeree & Ames (1976) indicate that is better to represent data for regression lines as a percentage of maximum since an individual's regression line can vary depending on their VO_{2max}. Thus, VO_2 and HR values are represented as a percentage of maximum in this study. RPE values were left as absolute figures.

An analysis of variance was then used to determine whether the regressions were significantly different. The 0.01 and 0.05 alpha level was used to determine significance for the regression equations.

Chapter IV

RESULTS

Introduction

This study was designed to evaluate the appropriateness of HR and RPE as a measure of intensity during three variations of aerobic dance. The relationship of the variables VO2, HR and RPE during aerobic dance were compared with those in the treadmill exercise.

Regressions

Percent Maximal Oxygen Uptake - Percent Maximal Heart Rate Regression (TM vs HI/LO)

Figure 1 shows a scattergram of the relationship between mean $\%VO_{2max}$ and mean $\%HR_{max}$. Mean values represent each minute during 16 minutes of TM exercise and 39 minutes of Hi/Lo aerobics. The equation representing the regression line for TM exercise is Y=31.3136 + 0.7333x. This regression had a significant correlation of 0.99. The regression line for the Hi/Lo aerobics is represented by the equation

Y= 44.6669 + 0.5588x with a significant correlation of 0.85. Examination of the relationship between the two lines reveals that while the slopes are not significantly different ($p<0.01$), the intercepts are significantly different ($p<0.01$) and the lines are significantly different ($p<0.01$).

Percent Maximal Oxygen Uptake - Percent Maximal Heart Rate Regression (TM vs INT)

Figure 2 shows a scattergram of the relationship between mean $\%VO_{2max}$ and mean $\%HR_{max}$. Mean values represent each minute during 16 minutes of TM exercise and 39 minutes of Interval aerobics. The equation representing the regression line for TM exercise is Y=31.3136 + 0.7333x. This regression had a significant correlation of 0.99. The regression line for the Interval aerobics is represented by the equation Y= 42.0979 + 0.6178x with a significant correlation of 0.84. Analysis of the relationship between the two lines reveals that the slopes are not significantly different ($p<0.05$), the intercepts are significantly different ($p<0.01$) and the lines are significantly different ($p<0.01$).

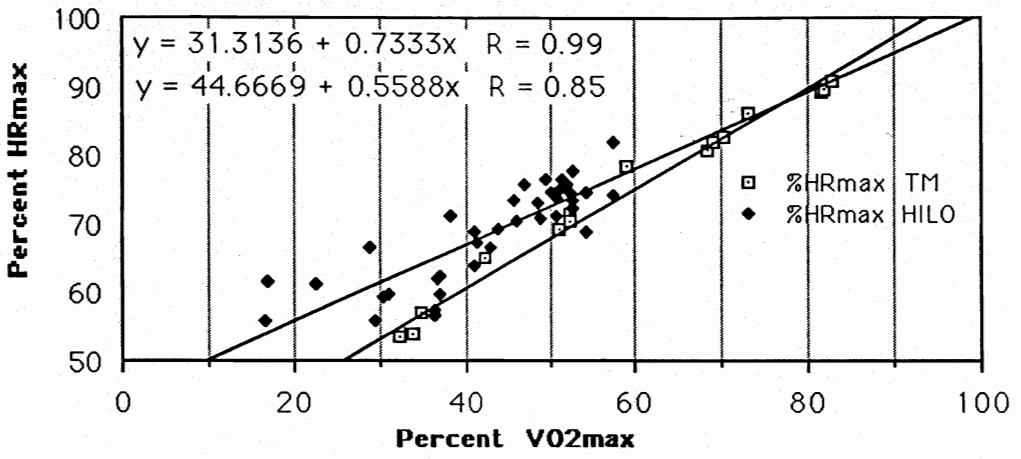

Figure 1. Percent maximal oxygen uptake-heart rate regressions for thirteen (one male, 12 female) trained aerobic instructors/participants during Treadmill (TM) exercise and High/Low Impact (HI/LO) aerobic dance.

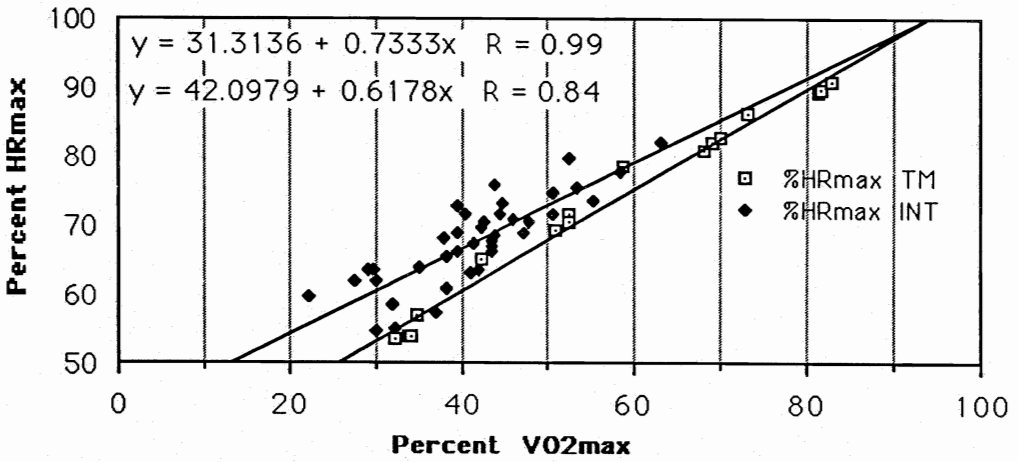

Figure 2. Percent maximal oxygen uptake-heart rate regressions for thirteen (one male, 12 female) trained aerobic instructors/participants during Treadmill (TM) exercise and Interval (INT) aerobic dance.

Percent Maximal Oxygen Uptake - Percent Maximal Heart Rate Regression (TM vs STEP)

Figure 3 shows a scattergram of the relationship between mean $\%VO_{2max}$ and mean $\%HR_{max}$. Mean values represent each minute during 16 minutes of TM exercise and 39 minutes of Step aerobics. The equation representing the regression line for TM exercise is Y=31.3136 + 0.7333x. This regression had a significant correlation of 0.99. The regression line for the Interval aerobics is represented by the equation Y= 39.8713 + 0.7291x with a significant correlation of 0.93. Analysis of the relationship between the two lines reveals that the slopes are not significantly different ($p<0.05$), the intercepts are significantly different ($p<0.05$) and the lines are significantly different ($p<0.01$).

The regression lines in Figures 1-3 shows the the intercept for aerobic dance is above the line for the TM exercise. This indicates that HR is higher for a given VO_2 during aerobic dance.

Percent Maximal Oxygen Uptake - Rating of Perceived Exertion Regression (TM vs HI/LO)

Figure 4 shows a scattergram of the relationship between mean $\%VO_{2max}$ and mean RPE. Mean values represent each minute during 16 minutes of TM exercise and 39 minutes of Step aerobics. The equation representing the regression line for TM exercise is Y= 2.5533 + 0.145x. This regression had a significant correlation of 0.99. The

regression line for the Interval aerobics is represented by the equation Y= 3.0904 + 0.136x with a significant correlation of 0.84. Analysis of the relationship between the two lines reveals that the slopes, intercepts and lines are not significantly different ($p<0.05$).

Percent Maximal Oxygen Uptake - Rating of Perceived Exertion Regression (TM vs INT)

Figure 5 shows a scattergram of the relationship between mean $\%VO_{2max}$ and mean RPE. Mean values represent each minute during 16 minutes of TM exercise and 39 minutes of Step aerobics. The equation representing the regression line for TM exercise is Y=2.5533 + 0.145x. This regression had a significant correlation of 0.99. The regression line for the Interval aerobics is represented by the equation Y= 3.5024 + 0.1163x with a significant correlation of 0.80. Analysis of the relationship between the two lines reveals that the slopes and intercepts are not significantly different ($p<0.05$). The lines are the same ($P<0.05$).

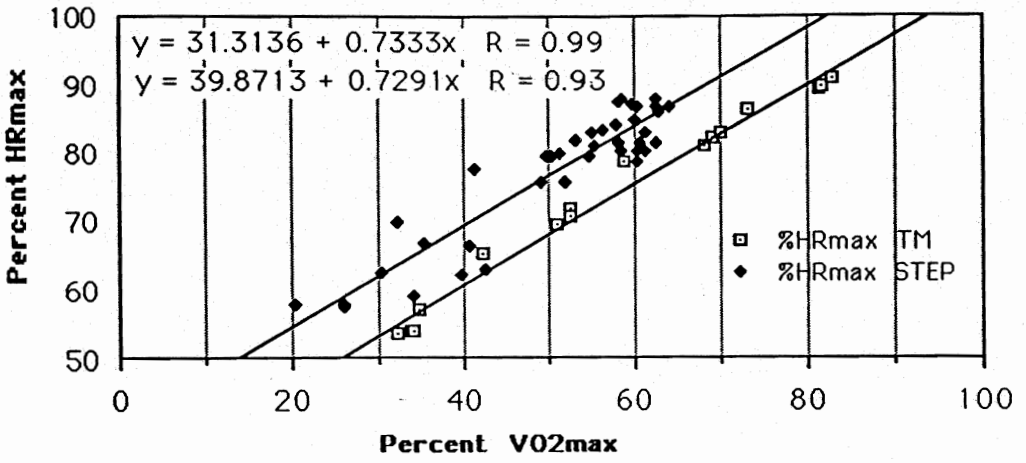

Figure 3. Percent maximal oxygen uptake-heart rate regressions for thirteen (one male, 12 female) trained aerobic instructors/participants during Treadmill (TM) exercise and Step (STEP) aerobic dance.

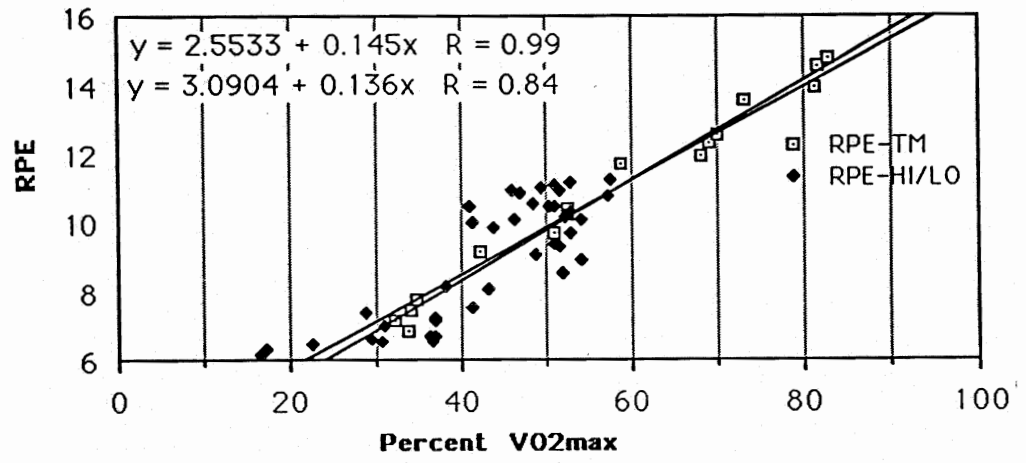

Figure 4. Percent maximal oxygen uptake-rating of perceived exertion regressions for thirteen (one male, 12 female) trained aerobic instructors/participants during Treadmill (TM) exercise and High/Low Impact (HI/LO) aerobic dance.

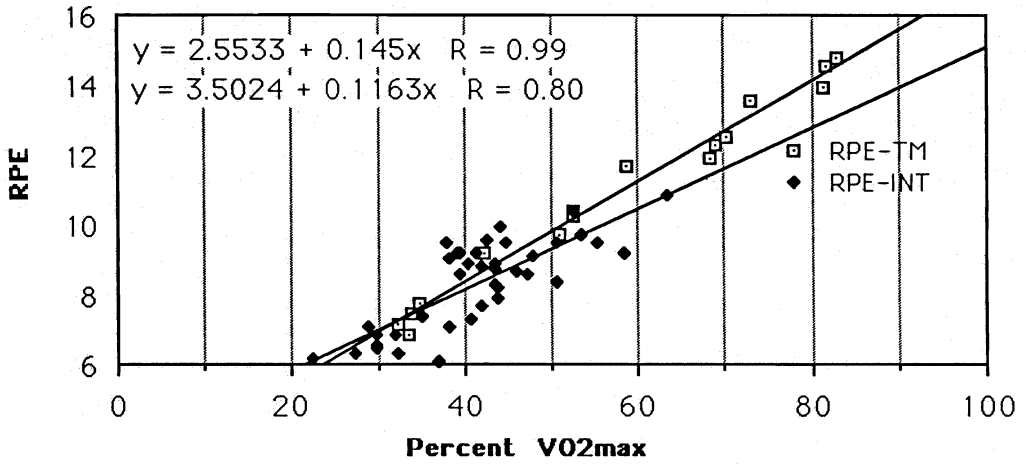

Figure 5. Percent maximal oxygen uptake-rating of perceived exertion regressions for thirteen (one male, 12 female) trained aerobic instructors/participants during Treadmill (TM) exercise and Interval (INT) aerobic dance.

Percent Maximal Oxygen Uptake - Rating of Perceived Exertion Regression (TM vs STEP)

Figure 6 shows a scattergram of the relationship between mean $\%VO_{2max}$ and mean RPE. Mean values represent each minute during 16 minutes of TM exercise and 39 minutes of Step aerobics. The equation representing the regression line for TM exercise is Y=2.5533 + 0.145x. This regression had a significant correlation of 0.99. The regression line for the Interval aerobics is represented by the equation Y= 2.5775 + 0.1423x with a significant correlation of 0.85. Analysis of the relationship between the two lines reveals that the slopes, intercepts and lines are not significantly different ($P<0.05$).

Percent Maximal Heart Rate-Time Relationship

Figure 7 represents the number of minutes that the heart rate is within the training zone of 60-90% of HR_{max} during the TM exercise and the three variations of aerobic dance. Table 2 shows that the TM, STEP, HI/LO and INT treatments were able to maintain this target zone for 12, 35, 32 and 34 minutes respectively.

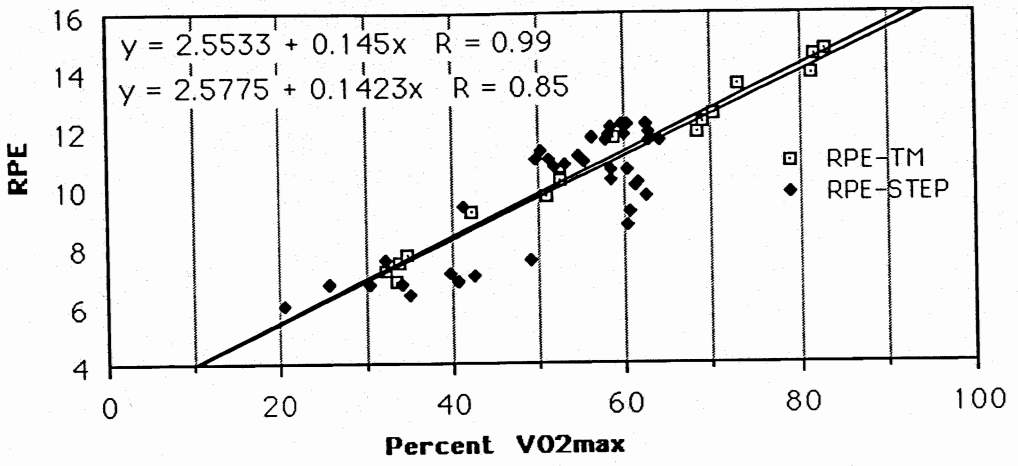

Figure 6. Percent maximal oxygen uptake-rating of perceived exertion regressions for thirteen (one male, 12 female) trained aerobic instructors/participants during Treadmill (TM) exercise and Step (STEP) aerobic dance.

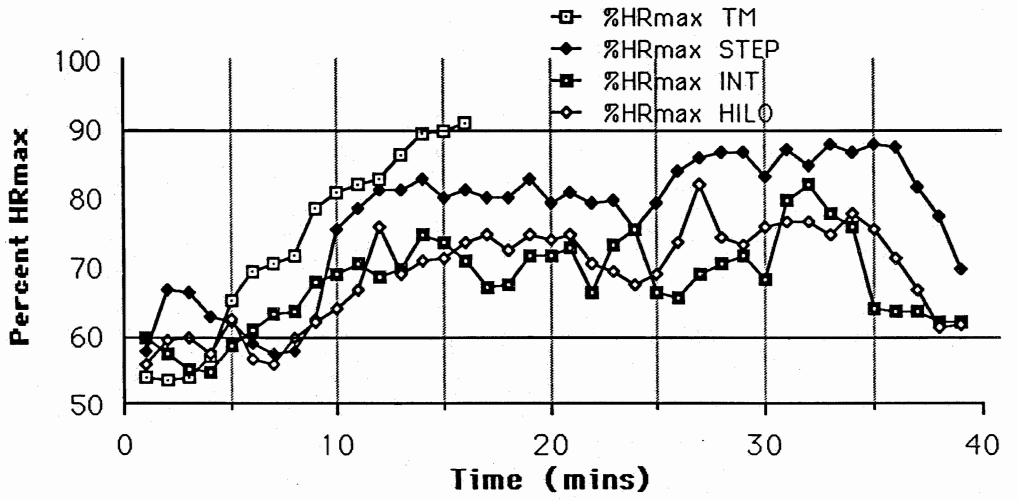

Figure 7. Percent maximal heart rate during 16 minutes of Treadmill (TM) exercise, and 39 minutes of Step (STEP), Interval (INT) and High/Low Impact (HI/LO) aerobics for 13 (one male, 12 female) trained aerobic instructors/participants.

Table 2. Mean number of minutes between 60-90% HRmax and the average percent (± standard deviation) during that time.

	Minutes Between 60-90% HRmax	Mean %HRmax
TM	12	79.64±8.88 Range = 64.93-90.93 SE = 2.57
STEP	35	79.13±7.46 Range = 62.03-87.8 SE = 1.26
HI/LO	32	71.25±5.16 Range = 61.13-81.76 SE = .91
INT	34	69.28±5.24 Range = 60.95-81.84 SE = .899

Percent Maximal Oxygen Uptake-Time Relationship

Figure 8 represents the number of minutes that the oxygen uptake is within the training zone of 50-85% of VO_{2max} during the TM exercise and the three variations of aerobic dance. Table 3 shows that for the TM, STEP, HI/LO and INT treatments this zone was achieved for 11, 31, 15 and 7 minutes respectively.

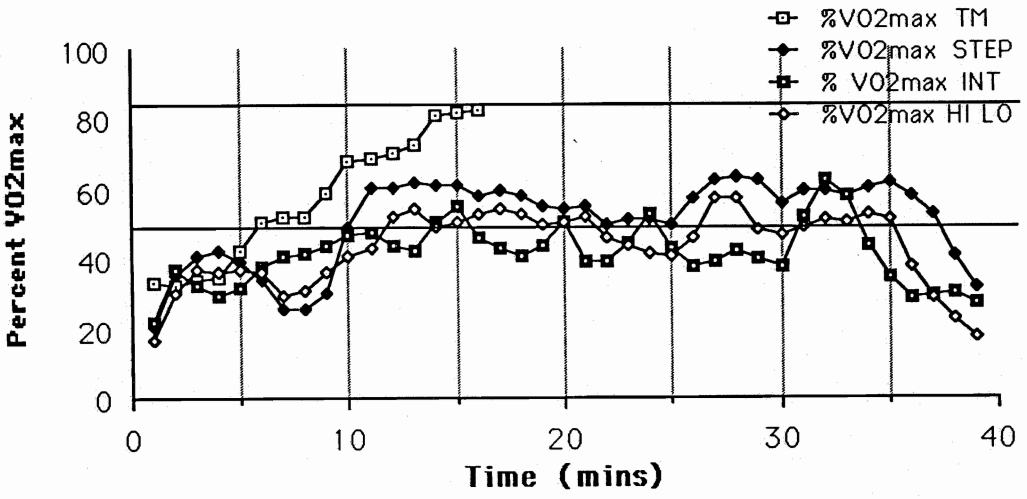

Figure 8. Percent maximal oxygen uptake during 16 minutes of Treadmill (TM) exercise, and 39 minutes of Step (STEP), Interval (INT) and High/Low Impact (HI/LO) aerobics for 13 (one male, 12 female) trained aerobic instructors/participants.

Table 3. Mean number of minutes between 50-85% VO_{2max} and the average percent (± standard deviation) during that time.

	Minutes Between 50-85% VO_{2max}	Mean %VO_{2max}
TM	11	67.37±12.11 Range = 51.04-82.84 SE = 3.65
STEP	31	54.68±9.72 Range = 20.42-63.94 SE = 1.75
HI/LO	15	52.79±2.195 Range = 50.3-57.47 SE = .567
INT	7	54.87±4.55 Range = 50.3-63.21 SE = 1.719

Rating of Perceived Exertion-Time Relationship

Figure 9 represents the number of minutes that the rating of perceived exertion is within the training zone of 12-16 RPE during the TM exercise and the three variations of aerobic dance. Table 4 shows that RPE was only maintained for 6 minutes during the TM exercise and 4 minutes for the STEP treatment. The other treatments did go into this zone at all.

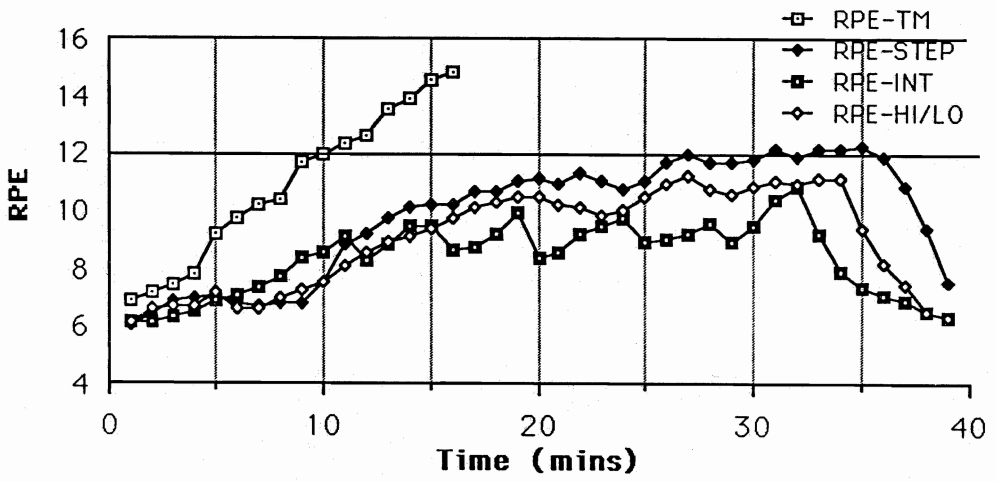

Figure 9. Ratings of perceived exertion during 16 minutes of Treadmill (TM) exercise, and 39 minutes of Step (STEP), Interval (INT) and High/Low Impact (HI/LO) aerobics for 13 (one male, 12 female) trained aerobic instructors/participants.

Table 4. Mean number of minutes between 12-16 RPE and the average RPE (± standard deviation) during that time.

	Minutes Between 12-16 RPE	Mean RPE
TM	6	13.60±1.02 Range = 12.31-14.77 SE = .414
STEP	4	12.14±0.04 Range = 12.08-12.17 SE = 0.02
HI/LO	0	
INT	0	

DISCUSSION

Results from this study indicate that the VO_2-HR linear relationship typically found in TM exercise (Londeree & Ames, 1976; Franklin, Hodgson, Buskirk, 1980; Taylor, Haskell, Fox, & Blackburn, 1969; cited in Parker et al., 1989), is not the same as that found in aerobic dance. This supports findings from previous studies (Parker et al., 1989, Hornsby et al

1991) and conflicts with others (Cline et al., 1990; Reeves et al., 1991). It is theorized that these discrepancies are due to the variability of arm and leg routines. Treadmill walking or running is repetition of the same movement whereas aerobic dance can have a large variety of movements. The regression lines for the STEP, INT and HI/LO treatments were significantly different from the TM exercise (Figures 1-3).

In addition, Figure 8, shows that monitoring intensity by heart rate would indicate that intensity is adequate. Table 3 shows that for the 39 minutes of each STEP, INT and HI/LO treatment, heart rates were in the 60-90% HR_{max} zone for 35, 32, and 34 minutes respectively when expressed over time. However, when examining oxygen uptake over time a different perspective can be seen. Figure 7 shows that only one or two of the aerobic dance conditions achieve the required 50-85% VO_{2max} zone. According to ACSM (1990) guidelines, 60-90% HR_{max} equates with approximately 50-85% VO_{2max}. Further examination of the data in Table 2 shows that the STEP treatment was within the 50-85% VO_{2max} zone for 31 mintues. However, the HI/LO and INT conditions were within this zone for only 15 and 7 minutes respectively.

For these subjects, intensity, as monitored by heart rates seemed adequate. However, measurement of VO_2 indicated that only the STEP treatment was intense enough to achieve this effect. The HI/LO condition would only minimally meet requirements and the INT condition would not produce a training effect.

In contrast, the regressions for the VO_2-RPE relationshipwere found to be not significantly different between aerobic dance treatments and TM

exercise. This indicates that RPE relates well to $\%VO_{2max}$. However, Figure 9 shows that mean RPE estimates only reached target zone levels for minimal amounts of time because VO_2 only reached these levels for a few minutes. In fact, Table 4 shows that the STEP treatment alone exceeds an RPE of 12 or more for only four minutes. Possible causes for this include the effect that music has on decreasing RPE scores.

Although group results indicate that RPE is a more appropriate method to monitor intensity, individual variability exists. For example two subjects were examined for individual data during the STEP treatment. At minute 32, subject MM was at 87.63% HR_{max}, 65.73% VO_{2max} and reported an RPE of 14 (somewhat hard). At the same time subject DK was at 88.04% HR_{max}, 60.14% VO_{2max} and reported an RPE of 9 (very light). This example illustrates two points. Firstly, there is a disproportionate increase in HR without a corresponding increase in VO_2, that is, although HR is approaching maximum, VO_2 is not. Secondly, a variety of RPE scores can be reported at similar intensities. The scattergrams in Figures 1-6 illustrate the variation.

Williford et al (1989) suggests other factors may influence the disproportionate HR responses. These include trying to follow the instructor or trying to keep up with the class. The additional stress placed on the participant could raise heart rate without increasing VO_2. In addition music could affect one's perceived exertion.

Possible mechanisms responsible for the disproportionate increases in HR could vary. Responses could be dependant on the amount of arm work above the head producing the positioning effect reported by

Astrand et al (1968). Also the amount of isometric work, if any combined with the dynamic exercise could have an effect. The percent of arm work contributing to the total energy cost could also cause variations. These possible variations that could occur during a typcial aerobic dance class may account for the discrepancies previously seen. For example while one individual is marching with knees up high, another could be marching with the feet barely coming off the ground. If both were working the arms vigorously, the latter individual may have more total energy contributed by the arms than the legs.

The amount of time teaching new routines can have an impact on hemodynamic responses. In the HI/LO treatment the teaching of a new routine caused VO_2, HR and RPE values to fall. During the INT treatment the changes in flow between aerobic routines, exertube routines and finding HR's caused overall VO_2 levels to be generally below target zone values. Some travelling movements were restricted under the conditions of the study but this limitation would not account for the total trend in lower values. In addition, typical oxygen uptake increases seen in interval training were not seen in this study except for the last interval routine. This was much more vigorous than the previous intervals. The STEP treatment had the greatest effect at controlling intensity since every subject had to lift their legs up a certain height.

Chapter V

CONCLUSIONS AND RECOMMENDATIONS

Summary

Thirteen healthy subjects (1 male, 12 female) were examined during 39 minutes in each of three variations of aerobic dance (STEP, INT, HI/LO) and for 16 minutes of TM exercise. Variables measured included VO_2, HR and RPE. Previous research has shown that the heart rate response can be disproportionate to increases in VO_2 during aerobic dance. The purpose of this study was to examine the VO_2-HR and VO_2-RPE relationship during the modes of exercise mentioned. Correlations, regression equations and analysis of variance were used to analyze the data. Data for VO_2 and HR were presented as a percentage of maximum. Absolute values were used for RPE. Results showed that the regression lines were significantly different ($p<0.01$) for the VO_2-HR relationship and not significantly different ($p<0.01$) for the VO_2-RPE relationship during the three variations of aerobic dance and TM exercise. Further analysis of the data revealed that the 60-90% HR_{max} training zone was achieved by the STEP, HI/LO and INT treatments for 12, 35, 32 and 34 minutes respectively. However, when data was analyzed for the 50-85% VO_{2max} training zone the STEP treatment achieved this for 31 minutes, whereas the HI/LO and INT treatments

achieved this zone for 15 and 7 minutes respectively. Results indicate that it may not be appropriate to use HR as a method to monitor intensity under the current guidelines by the ACSM, for aerobic dance. It appears that RPE is more appropriate. However, it is hypothesized that the music during the aerobic dance videotapes could have lowered subjects RPE slightly. Large individual differences were also noted at the same intensity. Therefore, results indicate that if heart rates are used, training should be 10 percent higher than those currently recommended ie. instead of 60-90% HRmax it should be 70-100% HRmax. This should be used in conjuction with the RPE scale but the zone could be lowered slightly to account for the effects of music.

Conclusions

The findings of the study do not support the first null hypothesis that there is no difference in the VO_2-HR regression for three variations of aerobic dance and treadmill walking/running. Monitoring intensity by heart rate with the aid of a 60-90% HRmax zone is not appropriate during aerobic dance. Target heart rates would need to be higher in order to achieve appropriate (ie. 50-85% VO_{2max}) VO_2 values. Results from the STEP treatment shows that 10 percent should be added onto current recommendations.

Findings do support the second null hypothesis that there is no difference in the VO_2-RPE regression analysis for three variations of

aerobic dance and treadmill walking/running but with certain limitations. It does appear to relate better to VO_2 levels but individual variations do exist at similar intensities. Previous studies have shown RPE to be a valid and reliable instrument (Stamford, 1976; Dunbar et al., 1992) and thus should not be discarded. To be used effectively standard instructions should be provided both verbally and written on charts (ACSM, 1991).

Boutcher & Trenske (1990) have shown that music can decrease a person's RPE at low and moderate levels of intensity. As music is used during aerobics this should be considered. Although there was a strong relationship between RPE and VO_2, results indicate there should be a reduction in the target zone slightly.

In a class situation when a large number of people may be attending, a combination of the target heart rate chart and a RPE chart would be appropriate. This would allow for individual variations.

Recommendations

1. Further studies need to be conducted to investigate the effects of positioning the arms above, at and below the shoulder level.

2. Further regression studies should control for the intensity of exercise. In the STEP treatment a much greater range of scores were obtained than in the HI/LO or INT treatments. Toner et al (1990) notes that

"submaximal exercise yields cardiovascular differences (eg. HR, SV, RPE) between upper and lower body exercise at similar levels of oxygen uptake. In low intensity exercise, however, these differences are minimized when slight involvement of the lower body is added to upper-body exercise"(p.777).

3. Studies could utilize a more homogeneous group of subjects and a larger sample size.

4. The effects of music on RPE during aerobic dance could be investigated.

5. The accuracy of measuring pulse rates during an aerobics class could also be examined.

6. Results of research such as this should be distributed directly back into the fitness industry. The sharing of this knowledge could be included as lecture presentations at aerobic conventions. Also by publications provided by the American Council on Exercise (A.C.E), the Aerobics and Fitness Association of America (A.F.A.A), the Institute of Aerobics Research (I.A.R) and the American College of Sports Medicine (A.C.S.M).

7. The producers of the aerobic videos used in this study could also be contacted to inform of the findings so that future videos can keep up to date with current research.

8. Training studies in aerobic dance could be conducted with the aid of the adjusted target heart rate zone chart ie. 70-100% HR_{max}. Only the health population should use this adjustment. In this way it could be seen if improvements in VO_{2max} were similar to those seen in studies using other modes of exercise.

9. The results of this study could be presented to the ACSM so that specific intensity quidelines for aerobic dance can be provided in their future guidelines documentation

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Health History Questionnaire

Personal Information

Name_____

Phone (work)_____ (home)_____

Address _____

City _____

Health History

Have you or your immediate family (dad, mom, brothers or sisters) had any of the following?
Y = Yes N = No

Concern	Family	You	Comments
Heart Attack (before 55 years)			
High Cholesterol (>25mg/dl)			
High Blood Pressure (>150/>90)			
Stroke			
Any Heart Trouble or Operation			
Disease of Blood Vessels			
Emphysema			
Bronchitis			
Asthma			
Diabetes			
Arthritis			

Your Present Symptoms

Have you recently had any of the following?

	Y or N	Explain
Chest Pain or Discomfort		
Indigestion Shortness of Breath		
Coughing of Blood		
Blood in Urine or Stools		
Frequenct Headaches		
Stiff Painful Joints or Bones		

Are you currently taking any medications? Yes/No
Please list if yes.

_____

_____

Are you more than 20 pounds overweight?	Yes	No
Are you pregnant?	Yes	No
Do you currently smoke?	Yes	No
If yes, how many cigarettes per day?	_____	
If yes, how long have you been smoking?	_____	
Have you ever quit smoking?	Yes	No
If yes, when did you quit?	_____	
If yes, for how long did you smoke?	_____	

Exercise History Questionnaire

Over the last three months have you engaged in regular physical activity? Yes No

If yes, what type of activity? _____

_____

How many days per week ? _____

_____

How much time per day ? _____

_____

Have you ever participated in aerobics before ? Yes No

If yes, for how many months or years?_____Years _____Months

Are you an aerobic instructor ____or participant____? (Check one)

If "instructor" checked, how long have you been teaching? _____

Check the classes you have attended or taught before.

Low Impact Aerobics	_____
High Impact Aerobics	_____
High/Low Combination	_____
Step Aerobics	_____
Interval Aerobics	_____

How would you rate your fitness level now?

Poor _____ Fair _____ Good _____ Excellent _____

Information You Need To Know Before Arriving For Each Appointment

1. The purpose of this study is to examin the effects of continuous aerobics (ie. high/low impact and step), interval aerobics and treadmill running on oxygen uptake, ratings of perceived exertion and heart rate.

2. You will be required for the following 5 appointments:

   i. Maximal oxygen uptake assessment (on a treadmill)
   ii. High/Low impact aerobics workout
   iii. Step aerobics workout
   iv. Interval aerobics workout
   v. Repeat (i.)

3. Please do not eat anything 3 hours prior to each appointment.

4. Please do not drink caffeine at least 3 hours prior to each appointment. You may drink water.

5. Please do not do any type of physical activity at any time during the day, prior to each appointment.

6. Wear shorts, t-shirt and running shoes for the maximal oxygen uptake assessment. Wear shorts, t-shirt and aerobic shoes for the aerobic workouts.

7. Please keep to your scheduled time. Phone 345-7629 (Brendan) or 581-3510 (Lab) if there are any problems with your time.

8. You need to report to the Human Performance Laboratory, Eastern Illinois University which is located in the Lantz Building (next to the 400m running track). Enter on the south side of the Lantz Building (right side of stairs at ground level). Walk north until you reach the end of the corridor. Turn right and the second door on your right is the Lab.

Informed Consent for Participation in Research Project

I, _____, state that I wish to particpate in the research project conducted by Brendan Roach.

The purpose of this study is to examin the effects of continous aerobics (ie. high/low impact, step), interval aerobics and treadmill running on oxygen uptake, ratings of perceived exertion and heart rate. My participation involves approximately four hours of time in the Human Performance Laboratory at Eastern Illinois University. These hours are divided into four separate exercise sessions as follows: Maximal oxygen uptake assessment on a treadmill, high/low aerobics workout, interval aerobics workout, and step aerobics workout. I understand that I will be following a videotape for the latter three workouts mentioned. During each session I will breath through a mouth piece which is designed to sample my expired air. My heart rate will be monitored with the use of a strap placed around my mid section (beneath my chest) and a watch placed on my wrist. I will also be asked my ratings of perceived exertion regularly. Resting data will also be collected which includes: height, weight, resting blood pressure and resting heart rate.

I agree to not do any other physical activity on the days I am to be assessed.

Benefits of this study include learning my maximal oxygen uptake consumption, and enjoying a variety of workouts. The personal risks are minimal and are those associated with sore muscles and fatigue. I understand that I can withdraw from this research project at any time without any questions being asked. If I have any questions Brendan Roach has offered to answer them. I consent to the anonymous use of my information for use in this research project. Any photographs or movies taken during this study may be used in the manuscript and or during lectures presenting this study.

I have read the above statement and do understand all risks and benefits associated with this study. I freely and voluntarily consent to my participation in this research project.

_____ _____ _____

Date Signature of Volunteer Signature of Witness

Informed Consent for Exercise Testing

In order to determine accurately my level of physical fitness and capacity for exercise, I hereby consent to engage voluntarily in an exercise tolerance test to evaluate the condition of my heart and circulation.

Before undergoing these tests, I understand my medical history will be reviewed to determine whether any condition is present which would indicate that I should not submit to these tests.

The tests which I will undergo will be performed on a treadmill with the amount of effort increasing gradually. The increase in effort will continue until symptoms such as fatigue, shortness of breath, or chest discomfort appear, symptoms which would indicate that the test should be stopped. I recognize that I stop the exercise at my discretion when I have reached a point where I no longer want to continue.

During the performance of the tests, trained observer will keep me under close surveillance by monitoring my heart rate and oxygen consumption.

There exists a possibility of certain changes occurring during the tests. They include abnormal blood pressure, fainting, disorders of heart beat, and in very rare instances heart attack. I understand that every effort will be made to minimize problems by preliminary examination and by observation during testing. I also understand that trained personnel will be available to deal with unusual situations which may arise.

I have read the foregoing carefully and I understand its content. Any questions which may have occurred to me concerning this informed consent have been answered to my satisfaction.

Date _____

Signature _____

Witnessed _____

Borg's Scale of Perceived Exertion

6	
7	Very, very light
8	
9	Very light
10	
11	Fairly light
12	
13	Somewhat hard
14	
15	Hard
16	
17	Very Hard
18	
19	Very, very hard
20	

Data Sheet

Name_____
Date_____
Age _____ Time_____
Sex _____ Age Pred. HR max _____
Weight (kg)_____ Height (cm)_____
BP (seated) (mmHg)_____ HR (seated) _____
Bar. Pressure (mmHg)_____ Temp (°C)_____
Humidity (%)_____

Medications Taken Today_____
VO_2max or Workout No. _____

Min	RPE	VO_2	HR	Min	RPE	VO_2	HR	Min	RPE	VO_2	HR
0				16				32			
1				17				33			
2				18				34			
3				19				35			
4				20				36			
5				21				37			
6				22				38			
7				23				39			
8				24				40			
9				25				41			
10				26				42			
11				27				43			
12				28				44			
13				29				45			
14				30				46			
15				31				47			

Treadmill VO_2max Test

Stage	Speed (mph)	Grade (%)	Duration
1	3.5	0	4:00
2	4.5	0	4:00
3	6.0	0	4:00
4	6.5	0	4:00
5	6.5	4	3:00
6	6.5	6	3:00
7	6.5	8	3:00
8	6.5	10	3:00
9	6.5	12	3:00

Note:

1. Stage one and two were walking stages.
2. Stage three and four were manipulated to achieve a comfortable running stage for the subject.
3. Stage one to four were for recording submaximal values.

INDIVIDUAL TREADMILL DATA

OXYGEN UPTAKE

HEART RATE

RATING OF PERCEIVED EXERTION

Subject	1 TM	2 TM	3 TM	4 TM	5 TM	6 TM	7 TM	8 TM	9 TM	10 TM	11 TM	12 TM
KW	15.47	16.69	14.26	15.82	19.47	24.52	25.91	25.21	27.99	30.60	29.73	31.65
% VO2 max	35.02	37.79	32.28	35.82	44.08	55.51	58.66	57.07	63.37	69.28	67.31	71.65
MF	7.92	14.13	14.13	14.40	17.30	21.40	21.93	22.99	27.48	34.35	35.41	34.88
% VO2 max	14.18	25.29	25.29	25.77	30.96	38.30	39.25	41.15	49.19	61.48	63.38	62.43
ET	12.20	14.47	15.16	15.69	18.13	22.14	23.10	22.31	26.67	29.28	30.68	29.98
% VO2 max	26.98	32.00	33.52	34.70	40.09	48.96	51.08	49.34	58.98	64.75	67.85	66.30
KC	13.43	13.85	13.85	13.85	18.01	21.61	21.33	21.75	25.07	29.64	29.78	30.47
% VO2 max	35.00	36.10	36.10	36.10	46.94	56.32	55.59	56.68	65.34	77.25	77.61	79.41
KN	18.04	14.26	17.68	16.87	20.29	27.52	28.93	28.12	28.73	30.54	29.73	33.55
% VO2 max	38.21	30.21	37.45	35.73	42.98	58.29	61.28	59.56	60.86	64.69	62.97	71.07
SH	14.23	12.68	14.13	12.84	15.89	19.59	18.94	20.23	22.16	26.97	28.10	27.30
% VO2 max	31.03	27.65	30.81	28.00	34.65	42.72	41.30	44.11	48.32	58.81	61.27	59.53
MM	17.66	14.44	16.30	14.95	18.00	23.95	23.27	23.44	25.82	27.35	28.71	28.88
% VO2 max	41.68	34.08	38.47	35.28	42.48	56.53	54.92	55.32	60.94	64.55	67.76	68.16
TN	17.20	14.63	15.02	15.42	15.02	20.17	18.58	19.97	22.14	29.85	30.84	30.25
% VO2 max	40.46	34.42	35.33	36.27	35.33	47.45	43.71	46.98	52.08	70.22	72.55	71.16
KB	15.55	12.28	12.75	13.53	15.86	20.21	20.99	21.30	23.63	26.28	26.90	27.68
% VO2 max	38.07	30.06	31.21	33.12	38.82	49.47	51.38	52.14	57.85	64.33	65.85	67.76
DK	13.46	13.64	14.90	14.54	17.95	21.91	22.44	24.42	27.29	35.91	35.38	33.22
% VO2 max	26.01	26.36	28.79	28.10	34.69	42.34	43.36	47.19	52.73	69.39	68.37	64.19
AB	19.19	13.78	14.48	18.49	29.14	27.22	28.09	27.92	28.97	30.36	29.84	30.19
% VO2 max	48.82	35.05	36.84	47.04	74.13	69.24	71.46	71.03	73.70	77.23	75.91	76.80
MP	10.88	13.77	15.37	15.37	15.85	16.65	19.85	16.97	21.13	26.26	26.10	27.54
% VO2 max	28.38	35.92	40.09	40.09	41.34	43.43	51.77	44.26	55.11	68.49	68.08	71.83
SK		15.32	15.68	16.05	19.29	24.70	26.33	25.60	29.75	34.44	34.80	36.24
% VO2 max	0.00	34.12	34.92	35.75	42.96	55.01	58.64	57.02	66.26	76.70	77.51	80.71
MEAN	14.60	14.15	14.90	15.22	18.48	22.43	23.05	23.09	25.91	30.14	30.46	30.91
STD DEVIATION	3.27	1.10	1.23	1.48	3.57	3.09	3.35	3.19	2.86	3.15	3.03	2.86
MEAN % VO2 max	33.65	32.23	33.93	34.75	42.27	51.04	52.49	52.45	58.82	68.24	68.95	70.08
STD DEV %VO2max	9.05	4.00	4.16	5.48	10.61	8.48	9.10	8.14	7.35	5.97	5.41	6.33

13 TM	14 TM	15 TM	16 TM
31.13	36.17	36.34	36.34
70.48	81.89	82.27	82.27
37.93	41.88	42.54	43.20
67.89	74.96	76.14	77.32
32.77	36.26	35.91	36.61
72.47	80.19	79.41	80.96
30.75	34.22	34.91	35.32
80.14	89.18	90.98	92.05
31.94	36.97	35.76	35.96
67.66	78.31	75.75	76.17
30.35	34.04	34.04	35.33
66.18	74.23	74.23	77.04
29.05	33.80	33.46	33.80
68.56	79.77	78.97	79.77
33.61	37.37	37.96	38.16
79.06	87.91	89.30	89.77
29.23	32.81	33.28	34.37
71.55	80.32	81.47	84.14
37.17	40.58	39.69	41.30
71.83	78.42	76.70	79.81
29.66	31.41	32.63	31.93
75.45	79.90	83.01	81.23
29.14	31.38	31.86	33.14
76.00	81.85	83.10	86.44
36.97	40.93	40.57	40.39
82.34	91.16	90.36	89.96
32.28	35.99	36.07	36.60
3.21	3.50	3.27	3.33
73.05	81.39	81.67	82.84
5.17	5.14	5.65	5.26

Subject	1 TM	2 TM	3 TM	4 TM	5 TM	6 TM	7 TM	8 TM	9 TM	10 TM	11 TM	12 TM
KW	95.00	99.00	97.00	93.00	121.00	124.00	126.00	129.00	137.00	132.00	138.00	137.00
%HR max	54.60	56.90	55.75	53.45	69.54	71.26	72.41	74.14	78.74	75.86	79.31	78.74
MF	97.00	92.00	-93.00	96.00	113.00	117.00	122.00	123.00	144.00	149.00	159.00	161.00
%HR max	49.49	46.94	47.45	48.98	57.65	59.69	62.24	62.76	73.47	76.02	81.12	82.14
ET	94.00	94.00	95.00	97.00	113.00	121.00	122.00	126.00	138.00	141.00	145.00	141.00
%HR max	51.65	51.65	52.20	53.30	62.09	66.48	67.03	69.23	75.82	77.47	79.67	77.47
KC	91.00	98.00	94.00	96.00	112.00	123.00	128.00	134.00	150.00	159.00	161.00	162.00
%HR max	48.92	52.69	50.54	51.61	60.22	66.13	68.82	72.04	80.65	85.48	86.56	87.10
KN	91.00	91.00	91.00	122.00	122.00	153.00	151.00	157.00	158.00	165.00	164.00	165.00
%HR max	45.50	45.50	45.50	61.00	61.00	76.50	75.50	78.50	79.00	82.50	82.00	82.50
SH	89.00	90.00	90.00	91.00	105.00	111.00	107.00	109.00	119.00	122.00	122.00	124.00
%HR max	53.29	53.89	53.89	54.49	62.87	66.47	64.07	65.27	71.26	73.05	73.05	74.25
MM	106.00	104.00	110.00	111.00	121.00	128.00	136.00	133.00	144.00	149.00	148.00	150.00
%HR max	56.99	55.91	59.14	59.68	65.05	68.82	73.12	71.51	77.42	80.11	79.57	80.65
TN	110.00	107.00	109.00	109.00	115.00	121.00	121.00	128.00	149.00	153.00	160.00	161.00
%HR max	60.11	58.47	59.56	59.56	62.84	66.12	66.12	69.95	81.42	83.61	87.43	87.98
KB	111.00	108.00	110.00	111.00	129.00	137.00	136.00	140.00	145.00	149.00	151.00	157.00
%HR max	55.22	53.73	54.73	55.22	64.18	68.16	67.66	69.65	72.14	74.13	75.12	78.11
DK	96.00	89.00	94.00	97.00	113.00	119.00	124.00	123.00	141.00	148.00	144.00	150.00
%HR max	52.17	48.37	51.09	52.72	61.41	64.67	67.39	66.85	76.63	80.43	78.26	81.52
AB	100.00	95.00	95.00	125.00	144.00	146.00	145.00	143.00	149.00	151.00	153.00	156.00
%HR max	59.17	56.21	56.21	73.96	85.21	86.39	85.80	84.62	88.17	89.35	90.53	92.31
MP	102.00	103.00	100.00	102.00	113.00	112.00	116.00	119.00	135.00	143.00	144.00	146.00
%HR max	59.65	60.23	58.48	59.65	66.08	65.50	67.84	69.59	78.95	83.63	84.21	85.38
SK	96.00	98.00	101.00	97.00	116.00	127.00	132.00	131.00	148.00	154.00	157.00	157.00
%HR max	54.55	55.68	57.39	55.11	65.91	72.16	75.00	74.43	84.09	87.50	89.20	89.20
MEAN	98.31	97.54	98.38	103.62	118.23	126.08	128.15	130.38	142.85	147.31	149.69	151.31
SD	7.12	6.42	7.12	11.01	9.78	12.48	11.86	11.91	9.49	11.12	11.49	11.78
MEAN %HRmax	53.95	53.55	53.99	56.83	64.93	69.10	70.23	71.42	78.29	80.70	82.00	82.87
SD %HRmax	4.42	4.45	4.44	6.29	6.80	6.59	6.17	5.69	4.72	5.18	5.33	5.24

13 TM	14 TM	15 TM	16 TM
146.00	156.00	153.00	156.00
83.91	89.66	87.93	89.66
170.00	174.00	174.00	180.00
86.73	88.78	88.78	91.84
154.00	160.00	162.00	165.00
84.62	87.91	89.01	90.66
170.00	176.00	176.00	177.00
91.40	94.62	94.62	95.16
173.00	178.00	176.00	177.00
86.50	89.00	88.00	88.50
135.00	141.00	143.00	144.00
80.84	84.43	85.63	86.23
157.00	161.00	167.00	166.00
84.41	86.56	89.78	89.25
165.00	172.00	174.00	174.00
90.16	93.99	95.08	95.08
164.00	168.00	168.00	172.00
81.59	83.58	83.58	85.57
149.00	155.00	155.00	157.00
80.98	84.24	84.24	85.33
150.00	153.00	157.00	158.00
88.76	90.53	92.90	93.49
153.00	158.00	158.00	162.00
89.47	92.40	92.40	94.74
162.00	166.00	167.00	170.00
92.05	94.32	94.89	96.59
157.54	162.92	163.85	166.00
11.07	10.67	10.22	10.41
86.26	89.23	89.76	90.93
3.90	3.86	3.97	3.89

Subject	1 TM	2 TM	3 TM	4 TM	5 TM	6 TM	7 TM	8 TM	9 TM	10 TM	11 TM	12 TM	13 TM
KW	7	7	8	8	9	11	12	12	13	13	13	13	14
MF	7	7	7	7	9	9	10	10	11	11	11	11	12
ET	6	6	7	7	7	7	9	9	10	10	11	12	13
KC	7	7	7	7	8	9	9	9	10	11	11	11	12
KN	6	6	6	6	7	7	7	7	8	8	8	8	10
DK	7	8	8	8	10	10	10	10	12	12	13	13	14
AB	6	7	7	9	10	11	11	12	13	13	13	14	14
MP	9	9	9	9	11	11	11	12	13	14	13	13	14
SK	6	6	6	7	9	10	11	10	12	13	14	14	15
SH	6	6	6	6	8	8	9	9	11	11	11	12	13
MM	8	8	9	9	10	11	11	11	13	13	13	13	14
TN	7	8	9	10	11	11	12	12	13	13	15	15	16
KB	7	8	8	8	10	11	11	12	13	13	14	14	15
MEAN	6.85	7.15	7.46	7.77	9.15	9.69	10.23	10.38	11.69	11.92	12.31	12.54	13.54
SD	0.90	0.99	1.13	1.24	1.34	1.55	1.42	1.61	1.60	1.66	1.84	1.81	1.56

14 TM	15 TM	16 TM
14	15	15
12	13	13
13	13	13
14	15	16
10	10	10
14	14	14
15	15	15
14	14	15
17	18	18
13	14	14
14	14	15
16	18	18
15	16	16
13.92	14.54	14.77
1.75	2.11	2.13

INDIVIDUAL HI/LO AEROBICS DATA

OXYGEN UPTAKE

HEART RATE

RATING OF PERCEIVED EXERTION

Subject	1 HILO	2 HILO	3 HILO	4 HILO	5 HILO	6 HILO	7 HILO	8 HILO	9 HILO	10 HILO	11 HILO	12 HILO
KW	0.88	2.11	15.14	15.31	15.31	15.84	11.26	12.32	15.31	17.95	20.07	24.47
% VO2max	1.99	4.78	34.28	34.66	34.66	35.86	25.49	27.89	34.66	40.64	45.44	55.40
MF	8.29	16.17	19.03	18.49	18.21	16.58	14.41	15.22	17.67	18.62	19.03	23.79
% VO2max	14.84	28.94	34.06	33.09	32.59	29.68	25.79	27.24	31.63	33.33	34.06	42.58
ET	5.91	17.56	16.86	15.82	17.39	18.78	13.39	14.95	16.34	19.82	19.47	24.52
% VO2max	13.07	38.83	37.28	34.98	38.46	41.53	29.61	33.06	36.13	43.83	43.06	54.22
KC	7.88	15.19	17.19	15.04	15.62	14.61	13.75	14.04	18.05	18.63	19.06	21.49
% VO2max	20.54	39.59	44.80	39.20	40.71	38.08	35.84	36.59	47.04	48.55	49.67	56.01
KN	10.18	15.68	16.49	18.94	18.12	18.73	11.4	14.05	15.27	18.53	20.36	24.23
% VO2max	21.56	33.21	34.93	40.12	38.38	39.67	24.15	29.76	32.34	39.25	43.13	51.32
SH	5.69	13.13	13.92	13.61	14.24	12.5	11.7	12.34	14.24	14.24	15.98	19.15
% VO2max	12.41	28.63	30.35	29.68	31.05	27.26	25.51	26.91	31.05	31.05	34.85	41.76
MM	12.05	14.43	14.94	15.11	15.78	15.44	12.9	13.75	15.44	18.33	18.33	23.59
% VO2max	28.44	34.06	35.26	35.66	37.24	36.44	30.45	32.45	36.44	43.26	43.26	55.68
TN	2.52	11.06	14.75	13.39	15.53	15.53	12.62	12.62	12.81	15.92	16.5	21.55
% VO2max	5.93	26.02	34.70	31.50	36.53	36.53	29.69	29.69	30.13	37.45	38.81	50.69
KB	4.38	11.58	14.55	14.71	14.39	13.14	11.26	11.11	14.39	16.58	17.68	18.77
% VO2max	10.72	28.35	35.62	36.01	35.23	32.17	27.56	27.20	35.23	40.59	43.28	45.95
DK	17.31	23.08	26.33	24.34	26.87	23.44	19.65	22.18	28.31	31.55	32.28	32.28
% VO2max	33.45	44.60	50.88	47.03	51.92	45.29	37.97	42.86	54.71	60.97	62.38	62.38
AB	3.11	10.91	14.03	16.11	14.9	16.98	12.82	12.47	14.38	16.81	18.02	25.3
% VO2max	7.91	27.75	35.69	40.98	37.90	43.20	32.61	31.72	36.58	42.76	45.84	64.36
MP	8.58	9.37	10.33	11.12	11.28	11.76	9.37	9.22	12.55	11.76	12.55	18.91
% VO2max	22.38	24.44	26.94	29.00	29.42	30.67	24.44	24.05	32.73	30.67	32.73	49.32
SK	9.97	16.74	20.48	18.52	16.74	16.92	14.78	14.42	17.45	18.88	18.88	20.84
% VO2max	22.20	37.28	45.61	41.25	37.28	37.68	32.92	32.12	38.86	42.05	42.05	46.41
MEAN	7.44	13.62	16.46	16.19	16.49	16.17	13.02	13.75	16.32	18.28	19.09	22.99
SD	4.43	4.98	3.89	3.30	3.62	3.07	2.48	3.02	3.99	4.55	4.47	3.62
MEAN %VO2 max	16.57	30.50	36.95	36.40	37.03	36.47	29.39	30.89	36.73	41.11	42.97	52.01
SD %VO2max	9.13	9.80	6.49	5.16	5.50	5.37	4.45	4.89	6.94	7.92	7.66	6.94

13 HILO	14 HILO	15 HILO	16 HILO	17 HILO	18 HILO	19 HILO	20 HILO	21 HILO	22 HILO	23 HILO	24 HILO	25 HILO	26 HILO
23.59	23.59	24.11	26.58	26.05	24.64	22.88	24.29	24.82	20.77	19.89	17.25	18.66	21.12
53.41	53.41	54.58	60.18	58.98	55.78	51.80	54.99	56.19	47.02	45.03	39.05	42.25	47.82
25.96	23.24	24.06	25.96	28.28	27.6	27.6	27.05	27.05	23.38	20.39	17.67	19.03	22.97
46.47	41.60	43.06	46.47	50.62	49.40	49.40	48.42	48.42	41.85	36.50	31.63	34.06	41.11
23.13	22.78	21.56	21.39	24.86	22.26	22.26	23.65	25.21	21.39	19.82	21.39	19.65	21.73
51.15	50.38	47.68	47.30	54.98	49.23	49.23	52.30	55.75	47.30	43.83	47.30	43.45	48.05
22.35	22.21	22.78	23.79	26.37	24.93	23.64	22.93	21.49	20.63	19.34	18.48	17.91	20.49
58.25	57.88	59.37	62.00	68.73	64.97	61.61	59.76	56.01	53.77	50.40	48.16	46.68	53.40
25.25	22.6	24.23	23.21	24.43	0	0	0	0	0	16.9	18.94	20.97	18.12
53.48	47.87	51.32	49.16	51.75	0.00	0.00	0.00	0.00	0.00	35.80	40.12	44.42	38.38
15.82	15.98	18.04	18.67	18.36	18.99	17.72	18.2	21.52	0	0	19.78	16.14	21.2
34.50	34.85	39.34	40.71	40.03	41.41	38.64	39.69	46.93	0.00	0.00	43.13	35.19	46.23
25.29	20.37	20.88	23.76	22.92	21.05	19.52	21.22	22.07	18.67	19.35	15.95	16.12	21.22
59.69	48.08	49.28	56.08	54.09	49.68	46.07	50.08	52.09	44.06	45.67	37.64	38.05	50.08
21.35	19.02	19.61	21.55	21.94	19.8	17.66	19.22	18.05	16.89	19.41	17.08	16.31	18.25
50.22	44.74	46.13	50.69	51.61	46.58	41.54	45.21	42.46	39.73	45.66	40.18	38.37	42.93
21.59	18.62	20.97	22.37	21.75	22.53	20.03	20.81	21.59	18.46	15.64	14.24	13.77	17.52
52.85	45.58	51.33	54.76	53.24	55.15	49.03	50.94	52.85	45.19	38.29	34.86	33.71	42.89
31.74	31.19	30.65	30.83	30.83	29.75	32.1	29.93	29.21	28.13	29.75	30.11	28.67	28.49
61.33	60.27	59.23	59.57	59.57	57.49	62.03	57.84	56.44	54.36	57.49	58.18	55.40	55.05
25.99	21.14	21.66	22.87	23.05	23.57	22.35	22.53	24.09	21.14	18.71	16.98	17.67	19.93
66.12	53.78	55.10	58.18	58.64	59.96	56.86	57.31	61.28	53.78	47.60	43.20	44.95	50.70
22.89	18.6	18.91	15.73	17.01	18.44	15.73	17.01	16.85	16.05	16.69	14.46	15.73	16.69
59.70	48.51	49.32	41.03	44.37	48.10	41.03	44.37	43.95	41.86	43.53	37.72	41.03	43.53
25.82	21.9	24.93	26.54	26	24.93	25.29	22.44	23.86	17.63	16.2	16.2	16.38	16.03
57.51	48.78	55.52	59.11	57.91	55.52	56.33	49.98	53.14	39.27	36.08	36.08	36.48	35.70
23.91	21.63	22.49	23.33	23.99	23.21	22.23	22.44	22.98	20.29	19.34	18.35	18.23	20.29
3.64	3.64	3.27	3.79	3.78	3.42	4.61	3.62	3.50	3.40	3.65	4.06	3.67	3.25
54.21	48.90	50.87	52.71	54.19	52.77	50.30	50.91	52.13	46.20	43.82	41.33	41.08	45.84
7.94	6.69	5.97	7.31	7.19	6.52	7.79	5.99	5.64	5.62	6.48	6.90	6.09	5.74

27 HILO	28 HILO	29 HILO	30 HILO	31 HILO	32 HILO	33 HILO	34 HILO	35 HILO	36 HILO	37 HILO	38 HILO	39 HILO
27.99	24.82	20.24	20.95	24.29	25	21.65	26.58	23.23	18.3	13.02	10.03	8.45
63.37	56.19	45.82	47.43	54.99	56.60	49.02	60.18	52.59	41.43	29.48	22.71	19.13
30.72	36.16	30.31	25.56	28.95	31.27	29.63	28.82	26.24	21.07	16.99	13.73	10.06
54.98	64.72	54.25	45.75	51.82	55.97	53.03	51.58	46.97	37.71	30.41	24.57	18.01
27.65	26.43	21.21	21.04	22.43	23.13	22.43	20.52	23.3	17.21	13.73	9.04	8.17
61.15	58.45	46.90	46.53	49.60	51.15	49.60	45.38	51.53	38.06	30.36	19.99	18.07
25.36	26.51	22.5	22.35	21.78	21.35	21.78	21.21	19.92	17.34	15.04	11.32	9.17
66.09	69.09	58.64	58.25	56.76	55.64	56.76	55.28	51.92	45.19	39.20	29.50	23.90
16.08	20.97	25.86	27.08	19.95	18.32	21.18	32.38	26.68	0	0	0	0
34.06	44.42	54.78	57.36	42.26	38.81	44.86	68.59	56.51	0.00	0.00	0.00	0.00
25.79	20.73	16.61	16.93	19.3	20.25	18.83	21.84	20.41	13.92	11.71	8.38	0
56.24	45.20	36.22	36.92	42.08	44.16	41.06	47.62	44.51	30.35	25.53	18.27	0.00
28.86	30.05	22.58	17.31	0	0	0	0	27.33	16.8	13.07	10.69	8.65
68.11	70.92	53.29	40.85	0.00	0.00	0.00	0.00	64.50	39.65	30.85	25.23	20.42
21.55	20.38	17.08	16.31	18.64	19.8	20.77	20.38	19.99	15.92	10.87	10.29	8.54
50.69	47.94	40.18	38.37	43.85	46.58	48.86	47.94	47.02	37.45	25.57	24.21	20.09
21.75	22.84	17.05	17.05	16.9	17.68	17.99	18.3	16.43	13.3	11.58	9.23	7.82
53.24	55.91	41.74	41.74	41.37	43.28	44.04	44.80	40.22	32.56	28.35	22.59	19.14
35.34	31.37	29.03	31.92	33	33.72	31.19	31.37	31.19	20.01	14.78	11.9	11.9
68.29	60.62	56.10	61.68	63.77	65.16	60.27	60.62	60.27	38.67	28.56	23.00	23.00
28.07	27.72	21.49	20.62	20.27	22.18	21.83	21.14	23.22	18.02	10.39	8.31	6.41
71.41	70.52	54.67	52.45	51.56	56.42	55.53	53.78	59.07	45.84	26.43	21.14	16.31
17.48	15.73	15.26	14.62	18.44	19.23	19.71	17.64	17.96	13.83	8.58	6.67	7.47
45.59	41.03	39.80	38.13	48.10	50.16	51.41	46.01	46.84	36.07	22.38	17.40	19.48
24.22	27.07	21.55	19.77	21.37	24.58	25.47	23.33	21.19	15.31	12.82	9.61	10.86
53.94	60.29	48.00	44.03	47.59	54.74	56.73	51.96	47.19	34.10	28.55	21.40	24.19
25.45	25.44	21.60	20.89	22.11	23.04	22.71	23.63	22.85	16.75	12.72	9.93	8.86
5.30	5.40	4.65	4.91	4.67	5.00	4.08	4.97	4.15	2.43	2.28	1.86	1.57
57.47	57.33	48.49	46.88	49.48	51.56	50.93	52.81	51.47	38.09	28.81	22.50	17.06
10.49	10.18	7.33	8.22	6.79	7.34	5.82	7.32	6.99	4.63	4.11	3.26	2.54

Subject	1 HILO	2 HILO	3 HILO	4 HILO	5 HILO	6 HILO	7 HILO	8 HILO	9 HILO	10 HILO	11 HILO	12 HILO	13 HILO	14 HILO
KW	99.00	97.00	99.00	92.00	92.00	90.00	91.00	97.00	106.00	106.00	107.00	127.00	115.00	122.00
% HR max	56.90	55.75	56.90	52.87	52.87	51.72	52.30	55.75	60.92	60.92	61.49	72.99	66.09	70.11
MF	88.00	103.00	104.00	97.00	106.00	88.00	104.00	103.00	103.00	112.00	109.00	140.00	124.00	125.00
% HR max	44.90	52.55	53.06	49.49	54.08	44.90	53.06	52.55	52.55	57.14	55.61	71.43	63.27	63.78
ET	102.00	105.00	108.00	109.00	120.00	98.00	104.00	107.00	120.00	120.00	123.00	145.00	123.00	126.00
% HR max	56.04	57.69	59.34	59.89	65.93	53.85	57.14	58.79	65.93	65.93	67.58	79.67	67.58	69.23
KC	106.00	120.00	116.00	105.00	114.00	113.00	105.00	115.00	121.00	126.00	127.00	141.00	139.00	147.00
% HR max	56.99	64.52	62.37	56.45	61.29	60.75	56.45	61.83	65.05	67.74	68.28	75.81	74.73	79.03
KN	120.00	122.00	125.00	125.00	139.00	130.00	125.00	126.00	131.00	135.00	140.00	156.00	145.00	149.00
% HR max	60.00	61.00	62.50	62.50	69.50	65.00	62.50	63.00	65.50	67.50	70.00	78.00	72.50	74.50
SH	93.00	99.00	99.00	93.00	104.00	99.00	98.00	94.00	98.00	102.00	108.00	113.00	97.00	106.00
% HR max	55.69	59.28	59.28	55.69	62.28	59.28	58.68	56.29	58.68	61.08	64.67	67.66	58.08	63.47
MM	109.00	111.00	107.00	111.00	118.00	111.00	105.00	118.00	123.00	122.00	128.00	144.00	135.00	132.00
% HR max	58.60	59.68	57.53	59.68	63.44	59.68	56.45	63.44	66.13	65.59	68.82	77.42	72.58	70.97
TN	91.00	101.00	99.00	99.00	112.00	95.00	98.00	96.00	102.00	104.00	119.00	135.00	112.00	116.00
% HR max	49.73	55.19	54.10	54.10	61.20	51.91	53.55	52.46	55.74	56.83	65.03	73.77	61.20	63.39
KB	109.00	121.00	118.00	110.00	128.00	116.00	113.00	117.00	120.00	129.00	133.00	144.00	130.00	141.00
% HR max	54.23	60.20	58.71	54.73	63.68	57.71	56.22	58.21	59.70	64.18	66.17	71.64	64.68	70.15
DK	116.00	122.00	130.00	129.00	136.00	115.00	116.00	135.00	139.00	146.00	141.00	150.00	144.00	150.00
% HR max	63.04	66.30	70.65	70.11	73.91	62.50	63.04	73.37	75.54	79.35	76.63	81.52	78.26	81.52
AB	88.00	100.00	100.00	99.00	109.00	94.00	85.00	100.00	104.00	108.00	121.00	140.00	125.00	123.00
% HR max	52.07	59.17	59.17	58.58	64.50	55.62	50.30	59.17	61.54	63.91	71.60	82.84	73.96	72.78
MP	95.00	94.00	94.00	91.00	95.00	89.00	86.00	94.00	95.00	97.00	106.00	132.00	121.00	118.00
% HR max	55.56	54.97	54.97	53.22	55.56	52.05	50.29	54.97	55.56	56.73	61.99	77.19	70.76	69.01
SK	104.00	114.00	115.00	105.00	111.00	106.00	100.00	111.00	111.00	113.00	115.00	131.00	127.00	131.00
% HR max	59.09	64.77	65.34	59.66	63.07	60.23	56.82	63.07	63.07	64.20	65.34	74.43	72.16	74.43
MEAN	101.54	108.38	108.77	105.00	114.15	103.38	102.31	108.69	113.31	116.92	121.31	138.31	125.92	129.69
SD	10.36	10.38	11.17	11.90	14.15	12.87	11.45	13.02	13.43	14.32	12.13	10.97	13.38	13.68
MEAN % HR max	55.60	59.31	59.53	57.46	62.41	56.55	55.91	59.45	61.99	63.93	66.40	75.72	68.91	70.95
SD %HRmax	4.68	4.15	4.82	5.23	5.86	5.52	4.03	5.65	5.96	6.04	5.17	4.31	5.94	5.61

15 HILO	16 HILO	17 HILO	18 HILO	19 HILO	20 HILO	21 HILO	22 HILO	23 HILO	24 HILO	25 HILO	26 HILO	27 HILO	28 HILO	29 HILO	30 HILO
129.00	125.00	132.00	126.00	128.00	131.00	123.00	121.00	115.00	111.00	113.00	128.00	149.00	121.00	124.00	132.00
74.14	71.84	75.86	72.41	73.56	75.29	70.69	69.54	66.09	63.79	64.94	73.56	85.63	69.54	71.26	75.86
128.00	136.00	141.00	140.00	141.00	145.00	157.00	129.00	132.00	120.00	132.00	138.00	170.00	163.00	144.00	155.00
65.31	69.39	71.94	71.43	71.94	73.98	80.10	65.82	67.35	61.22	67.35	70.41	86.73	83.16	73.47	79.08
127.00	128.00	139.00	127.00	140.00	135.00	140.00	127.00	129.00	130.00	126.00	138.00	151.00	131.00	134.00	138.00
69.78	70.33	76.37	69.78	76.92	74.18	76.92	69.78	70.88	71.43	69.23	75.82	82.97	71.98	73.63	75.82
146.00	157.00	157.00	154.00	159.00	153.00	155.00	147.00	144.00	140.00	144.00	150.00	175.00	164.00	160.00	161.00
78.49	84.41	84.41	82.80	85.48	82.26	83.33	79.03	77.42	75.27	77.42	80.65	94.09	88.17	86.02	86.56
146.00	153.00	153.00	144.00	152.00	147.00	139.00	125.00	134.00	135.00	142.00	129.00	136.00	144.00	160.00	151.00
73.00	76.50	76.50	72.00	76.00	73.50	69.50	62.50	67.00	67.50	71.00	64.50	68.00	72.00	80.00	75.50
105.00	110.00	114.00	110.00	113.00	117.00	123.00	0.00	0.00	106.00	114.00	127.00	137.00	119.00	110.00	114.00
62.87	65.87	68.26	65.87	67.66	70.06	73.65	0.00	0.00	63.47	68.26	76.05	82.04	71.26	65.87	68.26
133.00	137.00	136.00	130.00	131.00	132.00	135.00	125.00	124.00	123.00	129.00	141.00	158.00	142.00	136.00	140.00
71.51	73.66	73.12	69.89	70.43	70.97	72.58	67.20	66.67	66.13	69.35	75.81	84.95	76.34	73.12	75.27
130.00	125.00	125.00	122.00	125.00	124.00	124.00	130.00	123.00	120.00	127.00	143.00	147.00	128.00	122.00	134.00
71.04	68.31	68.31	66.67	68.31	67.76	67.76	71.04	67.21	65.57	69.40	78.14	80.33	69.95	66.67	73.22
143.00	149.00	150.00	149.00	148.00	153.00	152.00	140.00	136.00	131.00	130.00	147.00	156.00	142.00	142.00	150.00
71.14	74.13	74.63	74.13	73.63	76.12	75.62	69.65	67.66	65.17	64.68	73.13	77.61	70.65	70.65	74.63
142.00	143.00	143.00	138.00	149.00	137.00	139.00	146.00	138.00	143.00	140.00	141.00	150.00	138.00	145.00	153.00
77.17	77.72	77.72	75.00	80.98	74.46	75.54	79.35	75.00	77.72	76.09	76.63	81.52	75.00	78.80	83.15
121.00	133.00	130.00	132.00	132.00	130.00	139.00	123.00	119.00	110.00	115.00	127.00	149.00	137.00	130.00	130.00
71.60	78.70	76.92	78.11	78.11	76.92	82.25	72.78	70.41	65.09	68.05	75.15	88.17	81.07	76.92	76.92
109.00	112.00	112.00	111.00	117.00	117.00	117.00	115.00	116.00	115.00	114.00	115.00	121.00	106.00	108.00	117.00
63.74	65.50	65.50	64.91	68.42	68.42	68.42	67.25	67.84	67.25	66.67	67.25	70.76	61.99	63.16	68.42
136.00	138.00	140.00	135.00	134.00	131.00	133.00	122.00	117.00	115.00	114.00	117.00	141.00	130.00	124.00	128.00
77.27	78.41	79.55	76.70	76.14	74.43	75.57	69.32	66.48	65.34	64.77	66.48	80.11	73.86	70.45	72.73
130.38	134.31	136.31	132.15	136.08	134.77	136.62	129.17	127.25	123.00	126.15	133.92	149.23	135.77	133.77	138.69
13.00	14.38	13.71	13.28	13.72	12.01	12.74	10.07	9.64	11.88	11.40	10.97	14.19	16.31	16.46	14.68
71.31	73.44	74.54	72.28	74.43	73.72	74.76	70.27	69.17	67.30	69.02	73.35	81.76	74.23	73.08	75.80
5.00	5.60	5.13	5.12	5.27	3.84	5.03	4.93	3.64	4.75	3.96	4.84	6.93	6.76	6.27	5.09

31 HILO	32 HILO	33 HILO	34 HILO	35 HILO	36 HILO	37 HILO	38 HILO	39 HILO
133.00	127.00	131.00	140.00	122.00	119.00	109.00	110.00	105.00
76.44	72.99	75.29	80.46	70.11	68.39	62.64	63.22	60.34
160.00	160.00	151.00	159.00	155.00	142.00	142.00	120.00	111.00
81.63	81.63	77.04	81.12	79.08	72.45	72.45	61.22	56.63
140.00	138.00	124.00	132.00	132.00	129.00	116.00	105.00	107.00
76.92	75.82	68.13	72.53	72.53	70.88	63.74	57.69	58.79
161.00	162.00	157.00	164.00	168.00	161.00	152.00	135.00	140.00
86.56	87.10	84.41	88.17	90.32	86.56	81.72	72.58	75.27
142.00	138.00	152.00	152.00	147.00	155.00	158.00	137.00	129.00
71.00	69.00	76.00	76.00	73.50	77.50	79.00	68.50	64.50
119.00	118.00	114.00	124.00	122.00	111.00	110.00	97.00	0.00
71.26	70.66	68.26	74.25	73.05	66.47	65.87	58.08	0.00
0.00	0.00	0.00	0.00	137.00	126.00	124.00	119.00	116.00
0.00	0.00	0.00	0.00	73.66	67.74	66.67	63.98	62.37
135.00	139.00	134.00	138.00	133.00	129.00	121.00	115.00	116.00
73.77	75.96	73.22	75.41	72.68	70.49	66.12	62.84	63.39
146.00	153.00	146.00	152.00	150.00	145.00	135.00	125.00	127.00
72.64	76.12	72.64	75.62	74.63	72.14	67.16	62.19	63.18
153.00	144.00	143.00	149.00	137.00	128.00	108.00	105.00	111.00
83.15	78.26	77.72	80.98	74.46	69.57	58.70	57.07	60.33
132.00	136.00	130.00	140.00	138.00	119.00	104.00	87.00	97.00
78.11	80.47	76.92	82.84	81.66	70.41	61.54	51.48	57.40
117.00	124.00	122.00	120.00	121.00	108.00	105.00	96.00	102.00
68.42	72.51	71.35	70.18	70.76	63.16	61.40	56.14	59.65
135.00	139.00	133.00	132.00	127.00	118.00	106.00	105.00	102.00
76.70	78.98	75.57	75.00	72.16	67.05	60.23	59.66	57.95
139.42	139.83	136.42	141.83	137.62	130.00	122.31	112.00	113.58
14.07	13.50	13.37	13.66	14.13	16.35	18.67	15.01	12.80
76.38	76.63	74.71	77.71	75.28	70.98	66.71	61.13	61.65
5.39	5.07	4.46	5.06	5.51	5.81	7.05	5.48	4.97

Subject	1 HILO	2 HILO	3 HILO	4 HILO	5 HILO	6 HILO	7 HILO	8 HILO	9 HILO	10 HILO	11 HILO	12 HILO
KW	6	7	7	7	7	7	7	8	8	8	9	9
MF	6	6	6	6	7	6	6	6	6	6	6	7
ET	6	6	6	6	7	6	6	6	6	6	6	6
KC	6	6	7	6	7	6	6	7	7	7	8	8
KN	6	6	6	6	6	6	6	6	6	6	6	6
SH	6	6	6	6	6	6	6	6	6	7	8	8
MM	6	6	7	7	7	6	6	7	7	8	8	9
TN	6	7	7	7	8	8	8	8	8	9	9	10
KB	6	7	7	8	8	7	7	7	8	8	8	9
DK	6	7	7	8	8	7	7	8	9	9	10	10
AB	6	6	6	6	7	7	6	7	7	7	9	9
MP	7	7	7	6	7	6	7	7	7	8	8	9
SK	7	8	8	8	8	7	8	8	9	9	10	11
MEAN	6.15	6.54	6.69	6.69	7.15	6.54	6.62	7.00	7.23	7.54	8.08	8.54
SD	0.38	0.66	0.63	0.85	0.69	0.66	0.77	0.82	1.09	1.13	1.38	1.51

13 HILO	14 HILO	15 HILO	16 HILO	17 HILO	18 HILO	19 HILO	20 HILO	21 HILO	22 HILO	23 HILO	24 HILO	25 HILO	26 HILO
10	10	11	11	12	12	13	13	13	13	13	13	13	13
7	7	7	8	8	8	8	8	9	8	8	7	8	8
7	7	7	7	7	7	7	7	7	7	7	7	7	7
8	8	9	9	9	10	10	10	9	9	9	10	10	11
6	6	6	6	6	6	6	6	6	6	6	6	6	6
8	8	8	8	8	9	9	9	9	0	0	9	10	10
10	10	11	12	12	12	12	12	11	9	9	9	11	12
10	11	11	11	12	11	12	12	12	12	11	12	12	13
9	10	10	11	11	12	12	12	13	13	12	11	12	13
11	11	10	11	11	12	12	12	10	11	11	12	13	13
9	9	11	11	12	12	12	12	10	9	9	10	10	12
9	9	9	9	10	10	9	10	10	11	11	12	12	12
12	12	12	12	13	13	14	13	13	13	12	12	12	12
8.92	9.08	9.38	9.69	10.08	10.31	10.46	10.46	10.15	10.08	9.83	10.00	10.46	10.92
1.71	1.80	1.89	1.97	2.25	2.21	2.47	2.33	2.23	2.43	2.17	2.27	2.26	2.43

27 HILO	28 HILO	29 HILO	30 HILO	31 HILO	32 HILO	33 HILO	34 HILO	35 HILO	36 HILO	37 HILO	38 HILO	39 HILO
13	14	14	14	15	15	15	15	10	9	8	7	6
9	10	8	9	8	9	8	8	7	7	7	6	6
7	7	7	7	7	7	7	7	7	6	6	6	6
11	11	10	10	10	10	11	11	11	9	8	7	7
6	6	6	6	6	6	6	6	6	6	0	0	0
11	11	11	11	11	11	11	11	11	8	8	7	0
13	9	10	10	0	0	0	12	7	7	6	6	6
13	13	12	12	12	13	12	13	11	11	8	7	6
13	12	12	12	12	12	13	13	11	9	7	6	6
12	11	11	12	11	11	12	11	10	8	8	7	7
13	10	9	9	11	9	10	11	8	8	7	6	6
12	14	14	15	15	14	15	15	11	8	7	6	6
13	12	13	14	14	14	13	12	11	10	9	7	7
11.23	10.77	10.54	10.85	11.00	10.92	11.08	11.15	9.31	8.15	7.42	6.50	6.27
2.42	2.42	2.54	2.70	2.92	2.84	2.91	2.76	1.97	1.46	0.90	0.52	0.47

INDIVIDUAL INTERVAL AEROBICS DATA

OXYGEN UPTAKE

HEART RATE

RATING OF PERCEIVED EXERTION

Subject	1 INTERVAL	2 INTERVAL	3 INTERVAL	4 INTERVAL	5 INTERVAL	6 INTERVAL	7 INTERVAL	8 INTERVAL	9 INTERVAL
KW	2.92	15.12	12.20	11.85	13.75	17.87	20.11	20.11	17.18
%V02max	6.61	34.23	27.62	26.83	31.13	40.46	45.53	45.53	38.90
MF	8.25	23.42	18.68	18.00	18.68	20.85	23.96	23.15	23.96
%V02max	14.77	41.92	33.43	32.22	33.43	37.32	42.89	41.44	42.89
ET	10.88	18.66	14.86	10.54	16.76	16.41	18.49	20.04	18.14
%V02max	24.06	41.26	32.86	23.31	37.06	36.29	40.89	44.32	40.11
KC	7.01	15.99	15.01	12.90	12.34	16.83	17.11	17.81	19.64
%V02max	18.27	41.67	39.12	33.62	32.16	43.86	44.59	46.42	51.19
KN	5.73	18.97	16.60	14.62	15.01	19.36	17.58	21.54	26.48
%V02max	12.14	40.18	35.16	30.97	31.79	41.01	37.24	45.63	56.09
DK	18.47	20.94	18.30	16.89	22.35	24.99	26.04	26.57	24.11
%V02max	35.69	40.46	35.36	32.64	43.19	48.29	50.32	51.34	46.59
MM	3.54	15.00	11.80	14.16	12.64	16.18	17.02	17.36	17.70
%V02max	8.35	35.40	27.85	33.42	29.83	38.19	40.17	40.97	41.77
TN	7.94	14.53	12.40	12.79	10.85	14.15	16.28	16.08	16.66
%V02max	18.68	34.18	29.17	30.09	25.52	33.29	38.30	37.83	39.19
KB	12.98	14.21	10.35	11.43	13.13	15.61	15.30	15.91	16.38
%V02max	31.77	34.79	25.34	27.98	32.14	38.21	37.45	38.95	40.10
AB	12.17	16.46	15.43	13.55	12.34	15.95	17.49	19.38	20.75
%V02max	30.96	41.87	39.25	34.47	31.39	40.57	44.49	49.30	52.79
SH	12.32	12.48	10.92	9.67	11.54	12.79	13.72	15.28	14.97
%V02max	26.86	27.21	23.81	21.09	25.16	27.89	29.92	33.32	32.64
MP	12.62	9.87	9.38	8.89	9.54	11.00	11.81	11.00	14.72
%V02max	32.92	25.74	24.47	23.19	24.88	28.69	30.80	28.69	38.39
SK	13.01	18.54	20.68	17.29	16.75	19.07	21.39	17.82	20.68
%V02max	28.98	41.29	46.06	38.51	37.31	42.47	47.64	39.69	46.06
MEAN	9.83	16.48	14.35	13.28	14.28	17.00	18.18	18.62	19.34
SD	4.41	3.61	3.52	2.88	3.55	3.60	3.93	3.90	3.70
MEAN %V02max	22.31	36.94	32.27	29.87	31.92	38.20	40.79	41.80	43.59
SD %V02max	9.81	5.58	6.69	5.12	5.21	5.74	6.06	6.30	6.65

10 INTERVAL	11 INTERVAL	12 INTERVAL	13 INTERVAL	14 INTERVAL	15 INTERVAL	16 INTERVAL	17 INTERVAL	18 INTERVAL	19 INTERVAL
18.04	19.59	19.76	19.59	19.42	23.03	21.31	19.93	17.70	17.53
40.84	44.35	44.74	44.35	43.97	52.14	48.25	45.12	40.07	39.69
26.80	30.46	26.94	28.29	33.44	33.17	28.43	26.13	24.37	26.40
47.97	54.52	48.22	50.64	59.85	59.37	50.89	46.77	43.62	47.25
20.91	20.73	17.97	17.80	23.33	22.98	18.49	20.91	20.91	20.73
46.24	45.84	39.74	39.36	51.59	50.82	40.89	46.24	46.24	45.84
21.32	20.06	16.69	18.24	19.36	19.36	17.25	18.52	17.11	16.83
55.56	52.28	43.50	47.54	50.46	50.46	44.96	48.27	44.59	43.86
24.70	21.93	24.11	20.35	26.48	26.67	24.11	21.93	20.75	19.56
52.32	46.45	51.07	43.11	56.09	56.49	51.07	46.45	43.95	41.43
26.04	30.27	24.99	22.70	30.27	30.27	24.46	24.28	22.17	27.45
50.32	58.49	48.29	43.86	58.49	58.49	47.27	46.92	42.84	53.04
20.73	20.06	16.18	16.18	20.56	24.10	18.71	17.86	15.84	16.52
48.93	47.34	38.19	38.19	48.52	56.88	44.16	42.15	37.38	38.99
21.51	19.18	18.41	17.05	19.57	24.61	19.18	20.54	0.00	0.00
50.60	45.12	43.31	40.11	46.04	57.89	45.12	48.32	0.00	0.00
16.53	17.31	15.45	14.83	18.08	20.71	17.61	15.45	14.06	16.69
40.47	42.37	37.82	36.30	44.26	50.70	43.11	37.82	34.42	40.86
20.24	20.58	20.75	18.69	21.26	26.07	21.95	18.69	19.38	20.75
51.49	52.35	52.79	47.55	54.08	66.32	55.84	47.55	49.30	52.79
15.75	16.69	14.50	14.04	17.16	19.96	15.13	14.50	12.94	14.04
34.34	36.39	31.62	30.61	37.42	43.52	32.99	31.62	28.22	30.61
15.69	16.66	15.37	16.66	22.81	22.16	16.34	14.72	16.01	22.16
40.92	43.45	40.09	43.45	59.49	57.80	42.62	38.39	41.76	57.80
23.71	23.17	22.10	18.71	22.28	26.20	21.92	17.47	18.89	17.29
52.81	51.60	49.22	41.67	49.62	58.35	48.82	38.91	42.07	38.51
20.92	21.28	19.48	18.70	22.62	24.56	20.38	19.30	18.34	19.66
3.71	4.46	4.04	3.68	4.81	3.98	3.77	3.51	3.38	4.08
47.14	47.74	43.74	42.06	50.76	55.33	45.84	43.42	41.21	44.22
6.21	5.90	6.12	5.29	6.79	5.68	5.63	5.21	5.64	7.58

20 INTERVAL	21 INTERVAL	22 INTERVAL	23 INTERVAL	24 INTERVAL	25 INTERVAL	26 INTERVAL	27 INTERVAL	28 INTERVAL	29 INTERVAL
19.76	15.81	17.01	18.21	23.37	17.87	18.56	15.46	18.04	16.67
44.74	35.79	38.51	41.23	52.91	40.46	42.02	35.00	40.84	37.74
27.75	22.33	24.23	26.40	31.95	22.88	23.15	23.01	28.70	26.13
49.67	39.97	43.37	47.25	57.19	40.95	41.44	41.18	51.37	46.77
21.77	16.41	17.45	21.43	23.67	17.97	16.76	18.49	18.66	16.76
48.14	36.29	38.59	47.39	52.34	39.74	37.06	40.89	41.26	37.06
18.66	16.27	16.83	18.24	21.74	17.11	15.57	15.43	20.06	19.22
48.63	42.40	43.86	47.54	56.66	44.59	40.58	40.21	52.28	50.09
24.30	21.34	20.15	21.14	26.08	20.75	17.58	20.15	20.94	22.92
51.47	45.20	42.68	44.78	55.24	43.95	37.24	42.68	44.36	48.55
27.45	19.35	20.94	26.39	27.98	22.17	20.94	21.29	22.17	21.82
53.04	37.39	40.46	51.00	54.07	42.84	40.46	41.14	42.84	42.16
20.39	16.52	18.03	17.36	21.40	18.03	15.67	18.88	20.22	15.84
48.12	38.99	42.55	40.97	50.51	42.55	36.98	44.56	47.72	37.38
26.94	18.02	16.47	17.83	22.29	20.74	16.86	16.08	16.08	17.63
63.37	42.39	38.74	41.94	52.43	48.79	39.66	37.83	37.83	41.47
20.86	15.14	15.45	18.08	19.47	16.38	14.37	15.30	16.38	16.22
51.06	37.06	37.82	44.26	47.66	40.10	35.18	37.45	40.10	39.71
24.69	21.78	16.46	21.09	26.58	25.21	17.32	17.83	19.38	19.89
62.81	55.41	41.87	53.65	67.62	64.13	44.06	45.36	49.30	50.60
14.82	12.79	14.35	17.16	19.18	14.04	12.79	13.41	14.50	11.54
32.32	27.89	31.29	37.42	41.82	30.61	27.89	29.24	31.62	25.16
18.28	13.26	15.04	16.18	18.60	15.53	12.94	13.10	12.29	11.48
47.68	34.59	39.23	42.20	48.51	40.51	33.75	34.17	32.06	29.94
25.67	17.47	15.15	19.07	25.13	20.14	17.47	18.36	17.82	16.93
57.17	38.91	33.74	42.47	55.97	44.86	38.91	40.89	39.69	37.71
22.41	17.42	17.50	19.89	23.65	19.14	16.92	17.45	18.86	17.93
4.05	3.06	2.78	3.31	3.85	3.18	2.91	2.98	4.02	4.15
50.63	39.41	39.44	44.78	53.30	43.39	38.09	39.28	42.40	40.33
7.94	6.43	3.72	4.47	6.05	7.50	4.20	4.47	6.57	7.56

30 INTERVAL	31 INTERVAL	32 INTERVAL	33 INTERVAL	34 INTERVAL	35 INTERVAL	36 INTERVAL	37 INTERVAL	38 INTERVAL	39 INTERVAL
15.46	20.62	25.61	24.92	20.28	15.46	13.57	12.03	12.89	0.00
35.00	46.68	57.98	56.42	45.91	35.00	30.72	27.24	29.18	0.00
25.45	31.54	36.82	32.08	24.91	18.00	15.70	19.22	18.14	17.19
45.55	56.45	65.90	57.42	44.59	32.22	28.10	34.40	32.47	30.77
16.59	25.92	26.27	23.33	0.00	0.00	0.00	0.00	0.00	0.00
36.69	57.32	58.09	51.59	0.00	0.00	0.00	0.00	0.00	0.00
16.41	22.30	24.97	24.13	20.90	18.38	13.46	13.04	12.20	13.04
42.77	58.12	65.08	62.89	54.47	47.90	35.08	33.98	31.80	33.98
19.16	26.67	30.83	33.20	20.94	18.77	15.21	17.19	16.79	13.83
40.58	56.49	65.30	70.32	44.36	39.76	32.22	36.41	35.56	29.29
21.29	23.58	28.15	24.46	20.76	17.24	13.19	15.83	17.07	14.43
41.14	45.57	54.40	47.27	40.12	33.31	25.49	30.59	32.99	27.88
14.16	22.25	31.69	25.28	18.54	13.99	11.29	11.80	10.95	9.77
33.42	52.51	74.79	59.66	43.76	33.02	26.65	27.85	25.84	23.06
13.76	19.38	27.91	26.94	18.02	17.44	12.21	13.18	14.15	11.63
32.37	45.59	65.66	63.37	42.39	41.03	28.72	31.00	33.29	27.36
14.99	22.72	25.19	21.94	16.38	14.21	13.29	11.90	11.90	0.00
36.70	55.62	61.66	53.71	40.10	34.79	32.53	29.13	29.13	0.00
18.35	23.15	30.01	29.67	23.15	17.15	13.20	13.03	14.40	13.03
46.68	58.89	76.34	75.48	58.89	43.63	33.58	33.15	36.63	33.15
11.85	20.59	24.49	20.90	15.91	12.01	11.38	10.76	10.29	0.00
25.84	44.90	53.40	45.57	34.69	26.19	24.81	23.46	22.44	0.00
15.53	21.84	23.94	18.77	12.78	8.57	9.38	9.06	9.54	6.14
40.51	56.96	62.44	48.96	33.33	22.35	24.47	23.63	24.88	16.01
16.22	21.57	27.27	29.23	18.71	14.44	11.41	11.94	11.23	11.58
36.12	48.04	60.73	65.10	41.67	32.16	25.41	26.59	25.01	25.79
16.86	23.24	27.93	25.76	19.27	15.47	12.77	13.25	13.30	8.51
3.55	3.21	3.63	4.30	3.30	3.02	1.76	2.84	2.83	3.11
37.95	52.55	63.21	58.29	43.69	35.11	28.98	29.79	29.94	27.48
5.73	5.51	6.86	9.02	7.22	7.13	3.73	4.21	4.58	5.51

Subject	1 INTERVAL	2 INTERVAL	3 INTERVAL	4 INTERVAL	5 INTERVAL	6 INTERVAL	7 INTERVAL	8 INTERVAL	9 INTERVAL
KW	80.00	85.00	73.00	80.00	87.00	97.00	100.00	99.00	103.00
%HR max	45.98	48.85	41.95	45.98	50.00	55.75	57.47	56.90	59.20
MF	109.00	104.00	104.00	96.00	108.00	114.00	119.00	117.00	127.00
%HR max	55.61	53.06	53.06	48.98	55.10	58.16	60.71	59.69	64.80
ET	120.00	103.00	93.00	107.00	107.00	109.00	118.00	118.00	126.00
%HR max	65.93	56.59	51.10	58.79	58.79	59.89	64.84	64.84	69.23
KC	112.00	112.00	105.00	95.00	105.00	117.00	111.00	115.00	139.00
%HR max	60.22	60.22	56.45	51.08	56.45	62.90	59.68	61.83	74.73
KN	146.00	139.00	134.00	137.00	143.00	144.00	151.00	151.00	151.00
%HR max	73.00	69.50	67.00	68.50	71.50	72.00	75.50	75.50	75.50
DK	128.00	115.00	109.00	119.00	128.00	129.00	133.00	126.00	130.00
%HR max	69.57	62.50	59.24	64.67	69.57	70.11	72.28	68.48	70.65
MM	104.00	104.00	103.00	99.00	106.00	110.00	115.00	113.00	125.00
%HR max	55.91	55.91	55.38	53.23	56.99	59.14	61.83	60.75	67.20
TN	108.00	104.00	101.00	97.00	106.00	115.00	115.00	116.00	129.00
%HR max	59.02	56.83	55.19	53.01	57.92	62.84	62.84	63.39	70.49
KB	114.00	111.00	104.00	111.00	114.00	117.00	120.00	117.00	125.00
%HR max	56.72	55.22	51.74	55.22	56.72	58.21	59.70	58.21	62.19
AB	106.00	110.00	98.00	92.00	100.00	104.00	114.00	117.00	121.00
%HR max	62.72	65.09	57.99	54.44	59.17	61.54	67.46	69.23	71.60
SH	90.00	92.00	79.00	77.00	87.00	85.00	88.00	98.00	100.00
%HR max	53.89	55.09	47.31	46.11	52.10	50.90	52.69	58.68	59.88
MP	99.00	98.00	92.00	90.00	97.00	96.00	99.00	102.00	109.00
%HR max	57.89	57.31	53.80	52.63	56.73	56.14	57.89	59.65	63.74
SK	101.00	113.00	111.00	103.00	108.00	114.00	118.00	115.00	128.00
%HR max	57.39	64.20	63.07	58.52	61.36	64.77	67.05	65.34	72.73
MEAN	109.00	106.92	100.46	100.23	107.38	111.62	115.46	115.69	124.08
STD DEVIATION	16.55	12.93	15.03	15.95	15.11	14.90	15.55	13.39	13.84
MEAN %HRmax	59.53	58.49	54.87	54.70	58.65	60.95	63.07	63.27	67.84
STD DEV %HRmax	7.03	5.59	6.45	6.63	6.04	5.77	6.28	5.33	5.46

10 INTERVAL	11 INTERVAL	12 INTERVAL	13 INTERVAL	14 INTERVAL	15 INTERVAL	16 INTERVAL	17 INTERVAL	18 INTERVAL	19 INTERVAL
102.00	112.00	114.00	99.00	112.00	112.00	117.00	103.00	104.00	107.00
58.62	64.37	65.52	56.90	64.37	64.37	67.24	59.20	59.77	61.49
144.00	146.00	151.00	148.00	161.00	156.00	153.00	133.00	137.00	136.00
73.47	74.49	77.04	75.51	82.14	79.59	78.06	67.86	69.90	69.39
122.00	126.00	129.00	123.00	140.00	137.00	133.00	132.00	129.00	143.00
67.03	69.23	70.88	67.58	76.92	75.27	73.08	72.53	70.88	78.57
138.00	133.00	124.00	132.00	130.00	128.00	133.00	129.00	128.00	128.00
74.19	71.51	66.67	70.97	69.89	68.82	71.51	69.35	68.82	68.82
159.00	157.00	165.00	170.00	168.00	166.00	163.00	162.00	155.00	164.00
79.50	78.50	82.50	85.00	84.00	83.00	81.50	81.00	77.50	82.00
137.00	143.00	127.00	132.00	143.00	141.00	132.00	121.00	133.00	144.00
74.46	77.72	69.02	71.74	77.72	76.63	71.74	65.76	72.28	78.26
122.00	121.00	119.00	121.00	135.00	133.00	126.00	115.00	117.00	123.00
65.59	65.05	63.98	65.05	72.58	71.51	67.74	61.83	62.90	66.13
130.00	134.00	127.00	132.00	140.00	138.00	137.00	132.00	0.00	0.00
71.04	73.22	69.40	72.13	76.50	75.41	74.86	72.13	0.00	0.00
121.00	130.00	125.00	127.00	133.00	134.00	136.00	118.00	119.00	137.00
60.20	64.68	62.19	63.18	66.17	66.67	67.66	58.71	59.20	68.16
122.00	126.00	119.00	122.00	135.00	134.00	114.00	113.00	117.00	118.00
72.19	74.56	70.41	72.19	79.88	79.29	67.46	66.86	69.23	69.82
95.00	102.00	102.00	95.00	102.00	104.00	100.00	96.00	95.00	101.00
56.89	61.08	61.08	56.89	61.08	62.28	59.88	57.49	56.89	60.48
114.00	110.00	106.00	131.00	136.00	130.00	120.00	119.00	124.00	141.00
66.67	64.33	61.99	76.61	79.53	76.02	70.18	69.59	72.51	82.46
129.00	132.00	123.00	124.00	138.00	132.00	124.00	116.00	122.00	128.00
73.30	75.00	69.89	70.45	78.41	75.00	70.45	65.91	69.32	72.73
125.77	128.62	125.46	127.38	136.38	134.23	129.85	122.23	123.33	130.83
16.97	15.22	16.80	18.87	17.11	15.87	16.33	16.33	15.42	17.29
68.70	70.29	68.50	69.55	74.55	73.37	70.87	66.79	67.43	71.53
6.90	5.82	6.13	7.80	7.16	6.24	5.42	6.55	6.29	7.41

20 INTERVAL	21 INTERVAL	22 INTERVAL	23 INTERVAL	24 INTERVAL	25 INTERVAL	26 INTERVAL	27 INTERVAL	28 INTERVAL	29 INTERVAL
105.00	124.00	103.00	113.00	119.00	107.00	101.00	104.00	104.00	109.00
60.34	71.26	59.20	64.94	68.39	61.49	58.05	59.77	59.77	62.64
137.00	156.00	137.00	154.00	155.00	135.00	126.00	148.00	162.00	160.00
69.90	79.59	69.90	78.57	79.08	68.88	64.29	75.51	82.65	81.63
128.00	138.00	125.00	135.00	147.00	120.00	127.00	128.00	133.00	135.00
70.33	75.82	68.68	74.18	80.77	65.93	69.78	70.33	73.08	74.18
136.00	153.00	128.00	144.00	147.00	124.00	115.00	135.00	152.00	142.00
73.12	82.26	68.82	77.42	79.03	66.67	61.83	72.58	81.72	76.34
156.00	169.00	156.00	161.00	165.00	147.00	153.00	157.00	159.00	164.00
78.00	84.50	78.00	80.50	82.50	73.50	76.50	78.50	79.50	82.00
123.00	124.00	122.00	140.00	135.00	113.00	123.00	127.00	127.00	118.00
66.85	67.39	66.30	76.09	73.37	61.41	66.85	69.02	69.02	64.13
130.00	130.00	118.00	131.00	132.00	116.00	117.00	133.00	123.00	118.00
69.89	69.89	63.44	70.43	70.97	62.37	62.90	71.51	66.13	63.44
150.00	145.00	131.00	145.00	154.00	132.00	132.00	139.00	142.00	143.00
81.97	79.23	71.58	79.23	84.15	72.13	72.13	75.96	77.60	78.14
130.00	127.00	123.00	133.00	132.00	129.00	121.00	126.00	131.00	129.00
64.68	63.18	61.19	66.17	65.67	64.18	60.20	62.69	65.17	64.18
135.00	122.00	110.00	129.00	138.00	119.00	109.00	114.00	116.00	116.00
79.88	72.19	65.09	76.33	81.66	70.41	64.50	67.46	68.64	68.64
109.00	115.00	95.00	104.00	110.00	92.00	94.00	96.00	96.00	0.00
65.27	68.86	56.89	62.28	65.87	55.09	56.29	57.49	57.49	0.00
125.00	116.00	121.00	124.00	123.00	122.00	116.00	113.00	113.00	125.00
73.10	67.84	70.76	72.51	71.93	71.35	67.84	66.08	66.08	73.10
133.00	114.00	109.00	124.00	137.00	116.00	119.00	120.00	120.00	122.00
75.57	64.77	61.93	70.45	77.84	65.91	67.61	68.18	68.18	69.32
130.54	133.31	121.38	133.62	138.00	120.92	119.46	126.15	129.08	131.75
13.95	17.55	15.61	15.71	15.51	13.61	14.53	17.03	20.34	17.51
71.45	72.83	66.29	73.01	75.48	66.10	65.29	68.85	70.39	71.48
6.34	6.83	5.80	5.83	6.44	5.22	5.67	6.26	8.03	7.10

30 INTERVAL	31 INTERVAL	32 INTERVAL	33 INTERVAL	34 INTERVAL	35 INTERVAL	36 INTERVAL	37 INTERVAL	38 INTERVAL	39 INTERVAL
101.00	122.00	136.00	116.00	122.00	97.00	99.00	101.00	96.00	0.00
58.05	70.11	78.16	66.67	70.11	55.75	56.90	58.05	55.17	0.00
146.00	163.00	163.00	164.00	157.00	122.00	128.00	133.00	131.00	124.00
74.49	83.16	83.16	83.67	80.10	62.24	65.31	67.86	66.84	63.27
127.00	151.00	152.00	149.00	0.00	0.00	0.00	0.00	0.00	0.00
69.78	82.97	83.52	81.87	0.00	0.00	0.00	0.00	0.00	0.00
127.00	169.00	172.00	153.00	167.00	129.00	122.00	122.00	119.00	118.00
68.28	90.86	92.47	82.26	89.78	69.35	65.59	65.59	63.98	63.44
162.00	170.00	170.00	175.00	170.00	150.00	149.00	147.00	143.00	141.00
81.00	85.00	85.00	87.50	85.00	75.00	74.50	73.50	71.50	70.50
118.00	137.00	142.00	110.00	126.00	102.00	111.00	115.00	107.00	98.00
64.13	74.46	77.17	59.78	68.48	55.43	60.33	62.50	58.15	53.26
114.00	153.00	156.00	136.00	137.00	117.00	114.00	112.00	107.00	107.00
61.29	82.26	83.87	73.12	73.66	62.90	61.29	60.22	57.53	57.53
137.00	159.00	167.00	154.00	150.00	129.00	127.00	127.00	125.00	125.00
74.86	86.89	91.26	84.15	81.97	70.49	69.40	69.40	68.31	68.31
131.00	148.00	152.00	145.00	137.00	123.00	119.00	117.00	123.00	0.00
65.17	73.63	75.62	72.14	68.16	61.19	59.20	58.21	61.19	0.00
112.00	141.00	150.00	143.00	134.00	104.00	103.00	101.00	96.00	97.00
66.27	83.43	88.76	84.62	79.29	61.54	60.95	59.76	56.80	57.40
105.00	105.00	105.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
62.87	62.87	62.87	0.00	0.00	0.00	0.00	0.00	0.00	0.00
122.00	143.00	141.00	126.00	112.00	108.00	108.00	104.00	108.00	109.00
71.35	83.63	82.46	73.68	65.50	63.16	63.16	60.82	63.16	63.74
118.00	137.00	140.00	142.00	129.00	112.00	109.00	109.00	104.00	107.00
67.05	77.84	79.55	80.68	73.30	63.64	61.93	61.93	59.09	60.80
124.62	146.00	149.69	142.75	140.09	117.55	117.18	117.09	114.45	114.00
16.76	18.47	17.91	18.79	18.70	15.28	14.08	14.33	14.96	14.29
68.05	79.78	81.84	77.51	75.94	63.70	63.50	63.44	61.97	62.03
6.26	7.67	7.68	8.41	7.81	5.93	5.00	5.01	5.26	5.45

Subject	1 INTERVAL	2 INTERVAL	3 INTERVAL	4 INTERVAL	5 INTERVAL	6 INTERVAL	7 INTERVAL	8 INTERVAL	9 INTERVAL
KW	6	7	7	7	7	7	8	9	9
MF	6	6	6	6	6	6	6	6	6
ET	7	6	6	6	7	6	6	6	7
KC	6	6	6	7	7	8	8	8	10
KN	6	6	6	6	6	6	6	6	6
MM	6	6	6	7	8	8	9	8	10
TN	6	6	6	6	7	8	8	8	9
KB	6	6	7	7	7	7	8	9	9
DK	6	6	7	7	7	8	8	8	9
AB	6	6	6	6	6	7	7	7	7
SH	6	6	6	6	7	7	7	8	8
MP	7	6	7	7	7	7	7	9	9
SK	6	6	6	6	7	7	7	8	9
MEAN	6.15	6.08	6.31	6.46	6.85	7.08	7.31	7.69	8.31
SD	0.38	0.28	0.48	0.52	0.55	0.76	0.95	1.11	1.38

10 INTERVAL	11 INTERVAL	12 INTERVAL	13 INTERVAL	14 INTERVAL	15 INTERVAL	16 INTERVAL	17 INTERVAL	18 INTERVAL	19 INTERVAL	20 INTERVAL
9	10	10	10	11	11	12	10	12	12	9
7	7	6	7	7	8	6	7	7	7	6
7	7	7	7	7	8	7	7	7	8	7
10	11	9	9	9	9	8	8	9	9	8
6	6	6	6	6	6	6	6	6	6	6
10	10	8	10	11	10	8	9	10	11	9
9	9	8	8	10	10	8	8	0	0	9
10	10	8	10	10	10	11	9	9	12	10
9	10	9	10	10	10	9	10	10	11	8
7	9	8	9	10	10	8	9	9	10	8
8	9	9	9	10	10	10	10	10	10	11
10	10	10	10	11	10	10	11	11	11	9
9	10	9	9	11	11	9	9	10	12	9
8.54	9.08	8.23	8.77	9.46	9.46	8.62	8.69	9.17	9.92	8.38
1.39	1.50	1.30	1.36	1.71	1.39	1.80	1.44	1.75	2.02	1.45

21 INTERVAL	22 INTERVAL	23 INTERVAL	24 INTERVAL	25 INTERVAL	26 INTERVAL	27 INTERVAL	28 INTERVAL	29 INTERVAL	30 INTERVAL	31 INTERVAL
9	10	10	11	11	11	11	11	9	11	12
7	7	7	7	6	6	6	7	7	7	8
7	7	7	8	7	7	7	7	7	7	7
8	9	10	10	8	8	9	10	9	8	9
6	6	6	6	6	6	6	6	6	6	6
9	10	10	11	8	10	10	10	8	12	13
9	11	11	12	9	10	11	12	10	11	12
10	10	11	9	11	10	10	10	11	10	11
9	9	9	10	9	10	9	10	8	9	10
8	10	10	10	8	8	8	9	8	10	12
10	10	11	11	11	10	10	10	11	11	11
10	10	11	10	11	12	12	11	11	12	12
9	10	10	11	10	9	10	11	10	9	12
8.54	9.15	9.46	9.69	8.85	9.00	9.15	9.54	8.85	9.46	10.38
1.27	1.52	1.71	1.75	1.86	1.87	1.91	1.81	1.68	1.98	2.22

32 INTERVAL	33 INTERVAL	34 INTERVAL	35 INTERVAL	36 INTERVAL	37 INTERVAL	38 INTERVAL	39 INTERVAL
12	9	8	7	7	7	6	0
8	7	6	6	6	6	6	6
8	7	0	0	0	0	0	0
10	9	8	8	7	7	6	6
6	6	6	6	6	6	6	6
12	9	8	7	7	7	6	6
13	10	9	8	7	6	6	6
12	10	7	7	7	7	6	0
10	9	8	8	8	7	8	7
13	8	7	7	7	7	6	6
11	11	9	8	7	7	7	0
12	12	8	7	7	7	7	6
14	12	11	9	9	8	8	8
10.85	9.15	7.92	7.33	7.08	6.83	6.50	6.33
2.34	1.86	1.38	0.89	0.79	0.58	0.80	0.71

APPENDIX L

INDIVIDUAL STEP AEROBICS DATA

OXYGEN UPTAKE

HEART RATE

RATING OF PERCEIVED EXERTION

Subject	1 STEP	2 STEP	3 STEP	4 STEP	5 STEP	6 STEP	7 STEP	8 STEP	9 STEP	10 STEP	11 STEP	12 STEP
KW	8.37	13.61	16.05	15.53	14.83	12.56	8.37	9.94	10.64	23.03	28.97	30.71
%V02max	18.95	30.81	36.34	35.16	33.57	28.44	18.95	22.50	24.09	52.14	65.59	69.53
MF	9.21	18.01	18.82	20.86	18.55	15.71	12.32	11.37	0.00	0.00	0.00	25.33
%V02max	16.48	32.24	33.69	37.34	33.20	28.12	22.05	20.35	0.00	0.00	0.00	45.34
ET	7.10	20.27	19.58	20.10	18.54	14.90	10.05	10.39	12.82	25.12	26.34	27.38
%V02max	15.70	44.83	43.30	44.45	41.00	32.95	22.22	22.98	28.35	55.55	58.25	60.55
KC	8.48	17.69	21.15	21.72	20.00	16.97	13.52	12.37	14.24	22.58	27.33	28.48
%V02max	22.10	46.10	55.12	56.61	52.12	44.23	35.24	32.24	37.11	58.85	71.23	74.22
KN	9.49	16.61	19.98	17.40	16.81	15.23	10.28	11.47	12.26	25.32	29.27	29.08
%V02max	20.10	35.18	42.32	36.86	35.61	32.26	21.78	24.30	25.97	53.63	62.00	61.60
SH	11.05	17.07	18.04	19.51	18.69	14.47	13.33	11.54	14.47	19.67	24.71	25.69
%V02max	24.10	37.22	39.34	42.54	40.75	31.55	29.07	25.16	31.55	42.89	53.88	56.02
MM	7.71	12.92	15.10	17.95	15.77	13.76	10.57	9.90	11.74	17.95	25.33	25.50
%V02max	18.20	30.49	35.64	42.36	37.22	32.48	24.95	23.37	27.71	42.36	59.78	60.18
TN	8.09	12.33	10.40	16.76	15.99	12.90	9.82	10.40	11.36	19.65	27.93	27.93
%V02max	19.03	29.00	24.46	39.43	37.61	30.35	23.10	24.46	26.72	46.22	65.70	65.70
KB	8.70	12.18	13.92	15.50	14.87	12.97	10.12	9.49	10.12	16.61	23.10	22.46
%V02max	21.30	29.82	34.08	37.94	36.40	31.75	24.77	23.23	24.77	40.66	56.55	54.98
DK	12.87	25.21	27.72	27.00	27.18	21.46	17.17	16.45	21.46	28.08	32.01	31.30
%V02max	24.87	48.71	53.57	52.17	52.52	41.47	33.18	31.79	41.47	54.26	61.86	60.48
AB	13.30	11.55	17.86	18.38	16.46	15.93	9.80	10.85	9.63	21.36	27.32	27.84
%V02max	33.83	29.38	45.43	46.76	41.87	40.52	24.93	27.60	24.50	54.34	69.50	70.82
MP	3.30	10.37	14.73	14.88	14.13	12.63	9.02	10.37	12.63	16.99	22.25	23.60
%V02max	8.61	27.05	38.42	38.81	36.85	32.94	23.53	27.05	32.94	44.31	58.03	61.55
SK	9.97	16.74	20.48	18.52	16.74	16.92	14.78	14.42	17.45	18.88	18.88	20.84
%V02max	22.20	37.28	45.61	41.25	37.28	37.68	32.92	32.12	38.86	42.05	42.05	46.41
MEAN	9.05	15.74	17.99	18.78	17.58	15.11	11.47	11.46	13.24	21.27	26.12	26.63
SD	2.55	4.14	4.23	3.24	3.37	2.46	2.57	1.98	3.37	3.62	3.54	3.10
MEAN %V02max	20.42	35.24	40.56	42.44	39.69	34.21	25.90	25.93	30.34	48.94	60.37	60.57
SD %V02max	5.82	7.19	8.35	6.27	6.18	5.11	5.08	3.95	6.01	6.44	7.77	8.59

13 STEP	14 STEP	15 STEP	16 STEP	17 STEP	18 STEP	19 STEP	20 STEP	21 STEP	22 STEP	23 STEP	24 STEP	25 STEP	26 STEP
28.09	28.09	26.70	27.05	24.08	24.43	23.03	23.90	22.51	21.46	23.03	25.13	22.86	27.92
63.60	63.60	60.45	61.24	54.52	55.31	52.14	54.11	50.96	48.59	52.14	56.89	51.75	63.21
29.39	28.98	30.88	27.63	31.02	30.07	27.22	28.17	27.63	25.87	26.82	27.49	25.73	28.58
52.60	51.87	55.27	49.45	55.52	53.82	48.72	50.42	49.45	46.30	48.00	49.20	46.05	51.15
28.42	28.42	27.20	26.16	25.30	25.99	24.78	25.99	25.64	23.91	24.78	22.01	22.70	28.07
62.85	62.85	60.15	57.85	55.95	57.47	54.80	57.47	56.70	52.87	54.80	48.67	50.20	62.07
28.63	28.34	27.62	25.75	23.16	22.44	22.73	23.45	24.17	20.86	21.29	22.44	20.14	22.87
74.62	73.86	71.98	67.11	60.36	58.48	59.24	61.12	62.99	54.37	55.49	58.48	52.49	59.60
28.48	30.26	28.88	26.90	28.28	27.49	21.95	25.12	25.32	22.35	24.13	23.93	23.34	28.28
60.33	64.10	61.17	56.98	59.90	58.23	46.49	53.21	53.63	47.34	51.11	50.69	49.44	59.90
24.22	25.69	25.52	20.97	25.52	23.57	22.92	21.13	23.57	21.30	20.97	21.62	20.81	25.85
52.81	56.02	55.65	45.73	55.65	51.40	49.98	46.08	51.40	46.45	45.73	47.14	45.38	56.37
27.68	26.34	26.51	26.01	25.67	24.16	22.99	23.66	22.99	22.48	22.99	21.64	22.15	25.00
65.33	62.17	62.57	61.39	60.59	57.02	54.26	55.84	54.26	53.06	54.26	51.07	52.28	59.00
29.47	27.74	27.74	26.58	27.93	26.97	27.74	21.96	24.85	23.50	22.73	24.08	22.54	27.36
69.32	65.26	65.26	62.53	65.70	63.44	65.26	51.66	58.46	55.28	53.47	56.65	53.02	64.36
23.89	22.31	23.41	20.88	25.00	23.10	20.41	21.36	19.77	18.67	19.93	20.41	20.56	22.31
58.48	54.61	57.31	51.11	61.20	56.55	49.96	52.29	48.40	45.70	48.79	49.96	50.33	54.61
32.01	32.19	31.30	30.76	32.91	32.01	29.15	30.76	28.43	24.86	27.72	27.72	27.00	32.37
61.86	62.20	60.48	59.44	63.59	61.86	56.33	59.44	54.94	48.04	53.57	53.57	52.17	62.55
26.97	27.67	27.49	26.09	27.14	25.56	25.56	23.11	24.86	23.64	23.81	24.51	21.71	24.86
68.61	70.39	69.93	66.37	69.04	65.02	65.02	58.79	63.24	60.14	60.57	62.35	55.23	63.24
24.36	22.55	23.90	22.55	24.06	24.81	22.10	23.15	23.75	21.80	20.60	20.30	19.84	23.15
63.54	58.82	62.34	58.82	62.75	64.71	57.64	60.38	61.95	56.86	53.73	52.95	51.75	60.38
25.82	21.90	24.93	26.54	26.00	24.93	25.29	22.44	23.86	17.63	16.20	16.20	16.38	16.03
57.51	48.78	55.52	59.11	57.91	55.52	56.33	49.98	53.14	39.27	36.08	36.08	36.48	35.70
27.49	26.96	27.08	25.68	26.62	25.81	24.30	24.17	24.41	22.18	22.69	22.88	21.98	25.59
2.38	3.13	2.37	2.74	2.82	2.75	2.58	2.76	2.20	2.31	3.02	3.11	2.67	4.01
62.42	61.12	61.39	58.24	60.21	58.37	55.09	54.68	55.35	50.33	51.36	51.82	49.74	57.86
6.32	7.05	5.22	6.26	4.34	4.23	5.81	4.60	5.02	5.67	5.92	6.46	4.81	7.66

27 STEP	28 STEP	29 STEP	30 STEP	31 STEP	32 STEP	33 STEP	34 STEP	35 STEP	36 STEP	37 STEP	38 STEP	39 STEP
28.44	27.74	27.39	25.13	26.87	26.87	30.36	30.19	30.54	27.22	23.03	16.05	12.39
64.39	62.80	62.01	56.89	60.83	60.83	68.73	68.35	69.14	61.63	52.14	36.34	28.05
31.15	32.37	31.69	27.09	30.07	32.10	33.32	35.08	35.08	32.37	27.77	20.04	16.39
55.75	57.94	56.72	48.49	53.82	57.45	59.64	62.79	62.79	57.94	49.70	35.87	29.34
28.24	29.80	29.80	26.34	27.72	28.59	29.11	28.59	27.90	26.16	25.82	19.06	12.30
62.45	65.90	65.90	58.25	61.30	63.22	64.37	63.22	61.70	57.85	57.10	42.15	27.20
27.62	27.62	28.34	26.76	26.18	27.05	23.30	25.75	26.18	25.75	25.17	21.58	18.56
71.98	71.98	73.86	69.74	68.23	70.50	60.72	67.11	68.23	67.11	65.60	56.24	48.37
29.27	28.68	26.90	21.76	23.34	26.50	27.29	28.09	28.48	27.49	24.92	18.99	13.64
62.00	60.75	56.98	46.09	49.44	56.13	57.81	59.50	60.33	58.23	52.79	40.22	28.89
26.66	27.64	27.96	24.06	26.82	26.50	25.52	26.17	29.10	24.71	23.90	18.69	0.00
58.13	60.27	60.97	52.46	58.48	57.78	55.65	57.06	63.45	53.88	52.12	40.75	0.00
29.19	27.85	29.36	26.01	26.34	26.51	27.85	30.20	28.02	26.68	22.99	17.28	13.08
68.89	65.73	69.29	61.39	62.17	62.57	65.73	71.28	66.13	62.97	54.26	40.78	30.87
28.13	27.74	27.74	25.43	26.97	28.51	28.32	29.47	27.74	28.13	24.66	21.00	17.72
66.17	65.26	65.26	59.82	63.44	67.07	66.62	69.32	65.26	66.17	58.01	49.40	41.68
23.89	24.84	24.05	21.04	23.41	21.51	21.67	25.00	23.25	20.41	19.77	15.18	11.39
58.48	60.81	58.87	51.51	57.31	52.66	53.05	61.20	56.92	49.96	48.40	37.16	27.88
32.55	33.44	31.83	28.79	32.73	31.12	31.12	32.37	32.55	31.65	30.40	24.32	16.81
62.90	64.62	61.51	55.63	63.25	60.14	60.14	62.55	62.90	61.16	58.74	47.00	32.48
26.79	26.79	27.14	26.61	25.74	26.09	25.91	26.61	25.39	25.91	23.64	18.38	13.83
68.15	68.15	69.04	67.69	65.48	66.37	65.91	67.69	64.59	65.91	60.14	46.76	35.18
24.36	25.56	25.26	23.00	24.51	19.09	9.77	8.27	0.00	0.00	0.00	0.00	0.00
63.54	66.67	65.88	59.99	63.93	49.79	25.48	21.57	0.00	0.00	0.00	0.00	0.00
24.22	27.07	21.55	19.77	21.37	24.58	24.47	23.33	21.19	15.31	12.82	9.61	10.86
53.94	60.29	48.00	44.03	47.59	54.74	54.50	51.96	47.19	34.10	28.55	21.40	24.19
27.73	28.24	27.62	24.75	26.31	26.54	26.00	26.86	27.95	25.98	23.74	18.35	14.27
2.60	2.42	2.87	2.66	2.94	3.48	5.85	6.42	3.79	4.56	4.32	3.69	2.66
62.83	63.94	62.64	56.31	59.64	59.94	58.33	60.28	62.39	58.08	53.13	41.17	32.19
5.27	3.91	6.70	7.75	6.15	5.99	11.05	12.81	5.83	9.11	9.13	8.64	7.12

Subject	1 STEP	2 STEP	3 STEP	4 STEP	5 STEP	6 STEP	7 STEP	8 STEP	9 STEP	10 STEP	11 STEP	12 STEP
KW	80.00	93.00	90.00	84.00	88.00	81.00	77.00	80.00	92.00	120.00	133.00	132.00
%HRmax	45.98	53.45	51.72	48.28	50.57	46.55	44.25	45.98	52.87	68.97	76.44	75.86
MF	102.00	125.00	119.00	116.00	116.00	103.00	107.00	104.00	114.00	144.00	136.00	150.00
%HRmax	52.04	63.78	60.71	59.18	59.18	52.55	54.59	53.06	58.16	73.47	69.39	76.53
ET	97.00	124.00	116.00	113.00	112.00	101.00	102.00	101.00	113.00	139.00	142.00	152.00
%HRmax	53.30	68.13	63.74	62.09	61.54	55.49	56.04	55.49	62.09	76.37	78.02	83.52
KC	112.00	125.00	131.00	125.00	123.00	114.00	105.00	110.00	108.00	144.00	157.00	165.00
%HRmax	60.22	67.20	70.43	67.20	66.13	61.29	56.45	59.14	58.06	77.42	84.41	88.71
KN	123.00	137.00	136.00	128.00	130.00	120.00	116.00	121.00	131.00	163.00	161.00	161.00
%HRmax	61.50	68.50	68.00	64.00	65.00	60.00	58.00	60.50	65.50	81.50	80.50	80.50
SH	110.00	123.00	121.00	114.00	109.00	105.00	107.00	107.00	111.00	128.00	136.00	137.00
%HRmax	65.87	73.65	72.46	68.26	65.27	62.87	64.07	64.07	66.47	76.65	81.44	82.04
MM	105.00	114.00	119.00	110.00	112.00	109.00	108.00	107.00	110.00	131.00	140.00	147.00
%HRmax	56.45	61.29	63.98	59.14	60.22	58.60	58.06	57.53	59.14	70.43	75.27	79.03
TN	105.00	127.00	119.00	113.00	111.00	115.00	110.00	107.00	120.00	140.00	150.00	157.00
%HRmax	57.38	69.40	65.03	61.75	60.66	62.84	60.11	58.47	65.57	76.50	81.97	85.79
KB	118.00	131.00	135.00	132.00	127.00	130.00	123.00	120.00	128.00	143.00	153.00	158.00
%HRmax	58.71	65.17	67.16	65.67	63.18	64.68	61.19	59.70	63.68	71.14	76.12	78.61
DK	133.00	149.00	143.00	132.00	136.00	121.00	125.00	132.00	137.00	151.00	146.00	151.00
%HRmax	72.28	80.98	77.72	71.74	73.91	65.76	67.93	71.74	74.46	82.07	79.35	82.07
AB	96.00	112.00	118.00	113.00	103.00	99.00	90.00	89.00	102.00	140.00	146.00	149.00
%HRmax	56.80	66.27	69.82	66.86	60.95	58.58	53.25	52.66	60.36	82.84	86.39	88.17
MP	95.00	103.00	103.00	98.00	100.00	98.00	95.00	93.00	107.00	118.00	124.00	126.00
%HRmax	55.56	60.23	60.23	57.31	58.48	57.31	55.56	54.39	62.57	69.01	72.51	73.68
SK	97.00	116.00	121.00	115.00	108.00	101.00	96.00	101.00	105.00	128.00	139.00	143.00
%HRmax	55.11	65.91	68.75	65.34	61.36	57.39	54.55	57.39	59.66	72.73	78.98	81.25
MEAN	105.62	121.46	120.85	114.85	113.46	107.46	104.69	105.54	113.69	137.62	143.31	148.31
SD	13.81	14.38	13.95	13.34	13.11	12.65	13.18	13.85	12.48	12.49	10.29	11.38
MEAN %HRmax	57.78	66.46	66.13	62.83	62.03	58.76	57.24	57.70	62.20	75.31	78.52	81.21
SD %HRmax	6.48	6.60	6.46	5.99	5.30	5.23	5.70	6.14	5.27	4.84	4.67	4.58

13 STEP	14 STEP	15 STEP	16 STEP	17 STEP	18 STEP	19 STEP	20 STEP	21 STEP	22 STEP	23 STEP	24 STEP	25 STEP	26 STEP
130.00	132.00	123.00	127.00	121.00	124.00	129.00	115.00	119.00	118.00	119.00	114.00	123.00	138.00
74.71	75.86	70.69	72.99	69.54	71.26	74.14	66.09	68.39	67.82	68.39	65.52	70.69	79.31
155.00	167.00	154.00	166.00	163.00	161.00	170.00	159.00	167.00	163.00	170.00	149.00	159.00	173.00
79.08	85.20	78.57	84.69	83.16	82.14	86.73	81.12	85.20	83.16	86.73	76.02	81.12	88.27
155.00	158.00	151.00	150.00	145.00	148.00	153.00	153.00	156.00	147.00	148.00	136.00	148.00	160.00
85.16	86.81	82.97	82.42	79.67	81.32	84.07	84.07	85.71	80.77	81.32	74.73	81.32	87.91
163.00	164.00	156.00	151.00	138.00	138.00	160.00	149.00	154.00	145.00	151.00	144.00	145.00	154.00
87.63	88.17	83.87	81.18	74.19	74.19	86.02	80.11	82.80	77.96	81.18	77.42	77.96	82.80
166.00	170.00	161.00	163.00	162.00	159.00	161.00	154.00	158.00	155.00	160.00	142.00	158.00	167.00
83.00	85.00	80.50	81.50	81.00	79.50	80.50	77.00	79.00	77.50	80.00	71.00	79.00	83.50
134.00	134.00	134.00	130.00	131.00	131.00	136.00	129.00	133.00	131.00	127.00	128.00	130.00	132.00
80.24	80.24	80.24	77.84	78.44	78.44	81.44	77.25	79.64	78.44	76.05	76.65	77.84	79.04
144.00	144.00	143.00	142.00	141.00	142.00	143.00	141.00	140.00	141.00	139.00	132.00	139.00	150.00
77.42	77.42	76.88	76.34	75.81	76.34	76.88	75.81	75.27	75.81	74.73	70.97	74.73	80.65
155.00	159.00	157.00	159.00	157.00	157.00	164.00	154.00	156.00	160.00	160.00	149.00	155.00	164.00
84.70	86.89	85.79	86.89	85.79	85.79	89.62	84.15	85.25	87.43	87.43	81.42	84.70	89.62
156.00	160.00	157.00	160.00	166.00	163.00	166.00	165.00	164.00	158.00	161.00	159.00	162.00	167.00
77.61	79.60	78.11	79.60	82.59	81.09	82.59	82.09	81.59	78.61	80.10	79.10	80.60	83.08
155.00	155.00	146.00	158.00	155.00	154.00	157.00	152.00	152.00	149.00	146.00	139.00	153.00	158.00
84.24	84.24	79.35	85.87	84.24	83.70	85.33	82.61	82.61	80.98	79.35	75.54	83.15	85.87
150.00	151.00	149.00	152.00	150.00	150.00	151.00	145.00	150.00	147.00	151.00	145.00	148.00	156.00
88.76	89.35	88.17	89.94	88.76	88.76	89.35	85.80	88.76	86.98	89.35	85.80	87.57	92.31
125.00	127.00	127.00	130.00	127.00	128.00	131.00	127.00	129.00	125.00	122.00	119.00	122.00	130.00
73.10	74.27	74.27	76.02	74.27	74.85	76.61	74.27	75.44	73.10	71.35	69.59	71.35	76.02
141.00	141.00	140.00	143.00	141.00	142.00	141.00	136.00	139.00	139.00	139.00	136.00	138.00	145.00
80.11	80.11	79.55	81.25	80.11	80.68	80.11	77.27	78.98	78.98	78.98	77.27	78.41	82.39
148.38	150.92	146.00	148.54	145.92	145.92	150.92	144.54	147.46	144.46	145.62	137.85	144.62	153.38
12.67	14.06	12.06	13.19	14.40	12.96	13.69	14.32	14.34	13.59	15.84	12.47	13.41	13.73
81.21	82.55	79.92	81.27	79.81	79.85	82.57	79.05	80.66	79.04	79.61	75.46	79.11	83.90
4.83	4.92	4.65	4.79	5.34	4.87	4.88	5.29	5.44	5.27	6.08	5.31	4.87	4.69

27 STEP	28 STEP	29 STEP	30 STEP	31 STEP	32 STEP	33 STEP	34 STEP	35 STEP	36 STEP	37 STEP	38 STEP	39 STEP
136.00	135.00	139.00	134.00	142.00	139.00	156.00	150.00	142.00	141.00	120.00	116.00	101.00
78.16	77.59	79.89	77.01	81.61	79.89	89.66	86.21	81.61	81.03	68.97	66.67	58.05
176.00	178.00	172.00	162.00	179.00	173.00	185.00	185.00	179.00	177.00	160.00	146.00	142.00
89.80	90.82	87.76	82.65	91.33	88.27	94.39	94.39	91.33	90.31	81.63	74.49	72.45
165.00	169.00	169.00	160.00	165.00	166.00	170.00	169.00	166.00	164.00	154.00	147.00	125.00
90.66	92.86	92.86	87.91	90.66	91.21	93.41	92.86	91.21	90.11	84.62	80.77	68.68
166.00	167.00	166.00	163.00	170.00	170.00	167.00	162.00	171.00	172.00	167.00	152.00	146.00
89.25	89.78	89.25	87.63	91.40	91.40	89.78	87.10	91.94	92.47	89.78	81.72	78.49
167.00	163.00	161.00	154.00	159.00	160.00	170.00	169.00	163.00	171.00	154.00	147.00	131.00
83.50	81.50	80.50	77.00	79.50	80.00	85.00	84.50	81.50	85.50	77.00	73.50	65.50
141.00	146.00	144.00	137.00	144.00	140.00	139.00	140.00	142.00	138.00	134.00	134.00	0.00
84.43	87.43	86.23	82.04	86.23	83.83	83.23	83.83	85.03	82.63	80.24	80.24	0.00
152.00	155.00	154.00	148.00	152.00	151.00	163.00	161.00	157.00	155.00	142.00	135.00	124.00
81.72	83.33	82.80	79.57	81.72	81.18	87.63	86.56	84.41	83.33	76.34	72.58	66.67
164.00	166.00	168.00	164.00	170.00	170.00	175.00	173.00	172.00	174.00	164.00	158.00	147.00
89.62	90.71	91.80	89.62	92.90	92.90	95.63	94.54	93.99	95.08	89.62	86.34	80.33
172.00	173.00	173.00	166.00	173.00	170.00	175.00	176.00	176.00	168.00	164.00	151.00	145.00
85.57	86.07	86.07	82.59	86.07	84.58	87.06	87.56	87.56	83.58	81.59	75.12	72.14
162.00	158.00	158.00	156.00	159.00	154.00	162.00	156.00	155.00	156.00	147.00	144.00	124.00
88.04	85.87	85.87	84.78	86.41	83.70	88.04	84.78	84.24	84.78	79.89	78.26	67.39
157.00	159.00	161.00	153.00	158.00	154.00	158.00	157.00	154.00	153.00	146.00	139.00	117.00
92.90	94.08	95.27	90.53	93.49	91.12	93.49	92.90	91.12	90.53	86.39	82.25	69.23
131.00	134.00	137.00	129.00	140.00	112.00	108.00	104.00					
76.61	78.36	80.12	75.44	81.87	65.50	63.16	60.82	0.00	0.00	0.00	0.00	0.00
151.00	149.00	151.00	146.00	154.00	153.00	160.00	157.00	156.00	152.00	143.00	131.00	120.00
85.80	84.66	85.80	82.95	87.50	86.93	90.91	89.20	88.64	86.36	81.25	74.43	68.18
156.92	157.85	157.92	151.69	158.85	154.77	160.62	158.38	161.08	160.08	149.58	141.67	129.27
13.96	13.71	12.20	12.16	12.33	17.07	19.36	20.11	12.24	12.89	13.83	11.38	14.55
85.85	86.39	86.48	83.06	86.98	84.65	87.80	86.56	87.71	87.14	81.44	77.20	69.74
4.90	5.25	4.91	4.93	4.74	7.31	8.28	8.61	4.28	4.43	5.85	5.38	6.13

Subject	1 STEP	2 STEP	3 STEP	4 STEP	5 STEP	6 STEP	7 STEP	8 STEP	9 STEP	10 STEP	11 STEP	12 STEP
KW	6	6	7	7	7	7	7	7	8	8	9	9
MF	6	6	6	6	6	6	6	6	0	0	7	7
ET	6	6	6	7	7	6	6	6	6	7	7	7
KC	6	7	7	8	8	7	7	7	7	8	9	9
KN	6	6	6	6	6	6	6	6	6	7	7	7
SH	6	7	7	7	7	7	6	7	7	8	8	8
MM	6	7	7	7	7	6	7	6	8	9	10	10
TN	6	7	7	7	8	8	8	8	8	9	9	10
KB	6	7	8	8	8	7	7	7	8	7	9	10
DK	6	6	7	7	7	7	6	6	7	7	7	7
AB	6	6	7	7	7	7	7	7	7	9	11	12
MP	6	6	7	7	7	7	7	7	7	9	10	11
SK	6	6	7	7	7	7	7	8	9	10	11	12
MEAN	6.00	6.38	6.85	7.00	7.08	6.77	6.69	6.77	6.77	7.54	8.77	9.15
SD	0.00	0.51	0.55	0.58	0.64	0.60	0.63	0.73	2.20	2.47	1.48	1.86

13 STEP	14 STEP	15 STEP	16 STEP	17 STEP	18 STEP	19 STEP	20 STEP	21 STEP	22 STEP	23 STEP	24 STEP	25 STEP	26 STEP
9	10	11	11	12	12	13	13	13	13	13	13	13	14
8	8	8	8	8	8	8	8	8	8	8	8	7	8
7	7	7	7	7	8	7	8	7	7	7	7	7	8
10	11	11	11	11	11	12	12	12	12	12	12	12	13
8	8	8	8	9	9	9	9	9	9	9	9	9	10
9	9	9	9	9	9	10	10	9	10	10	9	10	10
10	11	11	10	10	10	11	11	11	12	10	10	11	12
10	11	11	11	12	11	12	12	12	12	11	12	12	13
11	11	11	12	12	12	12	13	13	13	13	12	13	13
8	8	8	8	8	9	10	10	9	10	10	9	9	10
12	13	13	13	13	13	13	13	13	13	13	12	13	13
11	11	11	12	13	12	12	12	12	13	13	13	13	13
13	13	13	13	14	14	14	13	14	15	14	14	14	14
9.69	10.08	10.15	10.23	10.62	10.62	11.00	11.08	10.92	11.31	11.00	10.77	11.00	11.62
1.75	1.93	1.95	2.05	2.26	1.94	2.08	1.89	2.25	2.32	2.20	2.20	2.38	2.14

27 STEP	28 STEP	29 STEP	30 STEP	31 STEP	32 STEP	33 STEP	34 STEP	35 STEP	36 STEP	37 STEP	38 STEP	39 STEP
14	14	14	14	14	15	15	15	15	15	13	11	9
9	8	8	9	9	9	10	10	9	9	8	7	7
8	8	8	8	8	8	8	8	8	8	8	8	7
13	13	13	13	13	13	13	13	13	13	13	13	10
10	10	10	9	10	9	10	11	10	11	11	8	6
10	10	10	10	11	11	11	12	11	11	11	10	0
13	13	13	14	13	14	14	14	13	12	11	10	7
13	13	12	12	12	13	12	13	11	11	8	7	6
13	12	12	13	14	14	15	15	14	13	11	8	7
10	9	9	9	9	9	9	9	10	9	9	8	7
14	14	14	14	15	15	15	15	15	13	12	10	7
13	13	13	13	14	7	7	6	0	0	0	0	0
15	14	15	15	16	17	18	17	17	17	15	12	10
11.92	11.62	11.62	11.77	12.15	11.85	12.08	12.15	12.17	11.83	10.83	9.33	7.55
2.22	2.29	2.36	2.42	2.54	3.18	3.25	3.21	2.76	2.59	2.25	1.97	1.44

SUBJECT PHYSICAL CHARACTERISTICS

Subject	Age (years)	Weight (kg)	Height (cm)	No.1-V02 max (ml/kg/min)	No.2-V02 max (ml/kg/min)
KW	30.00	57.50	155.00	41.73	44.17
MF	20.00	74.10	169.00	55.87	54.70
ET	22.00	59.55	161.00	43.66	45.22
KC	31.00	68.90	170.00	37.01	38.37
KN	20.00	49.77	158.00	47.21	
DK	22.00	55.68	165.00	51.75	48.49
AB	42.00	58.00	167.00	39.31	
MP	37.00	66.50	163.50	38.34	
SK	33.00	55.30	158.00	41.41	44.90
SH	22.00	62.27	170.00	45.86	45.28
MM	40.00	59.00	160.50	42.37	42.13
TN	38.00	50.57	155.00	40.13	42.51
KB	19.00	63.90	159.50	40.85	
MEAN	**28.92**	**60.08**	**162.42**	**43.50**	**40.58**
STD DEVIATION	**8.49**	**6.99**	**5.40**	**5.43**	**4.55**
RANGE	**19-42**	**49.77-74.1**	**155-170**	**35.25-55.87**	**38.37-54.7**

Mean V02 max (ml/kg/min)	HR max	Resting HR	Participation (Years)
44.17	174.00	55.00	7.00
55.87	196.00	53.00	5.50
45.22	182.00	66.00	6.00
38.37	186.00	57.00	10.00
47.21	200.00	73.00	4.00
51.75	184.00	57.00	3.00
39.31	169.00	58.00	10.00
38.34	171.00	60.00	10.00
44.90	176.00	57.00	1.50
45.86	167.00	56.00	8.00
42.37	186.00	74.00	11.33
42.51	183.00	69.00	10.17
40.85	201.00	73.00	5.00
44.36	**182.69**	**62.15**	**7.04**
5.13	**11.28**	**7.70**	**3.15**
34.00-55.87	**167-201**	**53-74**	**1.5-11.33**